



A Celtic Feast: The Iron Age Cauldrons from Chiseldon, Wiltshire

Alexandra Baldwin and Jody Joy

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With contributions by Andrew
Armstrong, Alistair J. Barclay,
Hayley Bullock, Caroline R.
Cartwright, A.P. Fitzpatrick, Hazel
Gardiner, Michael J. Grant, Lorrain
Higbee, Jamie Hood, Allison Kerns,
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McHarg, Lorraine Mephram, Peter
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Alexandra Baldwin and Jody Joy

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Front cover: Andrew Armstrong (Wessex Archaeology) and Alexandra Baldwin (British Museum) preparing to lift a large fragment of cauldron

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Summary

This volume presents the results of the excavation and scientific analysis between 2005 and 2014 of a hoard of 17 Iron Age cauldrons and many large cauldron fragments, discovered in a large pit on farmland in the parish of Chiseldon, Wiltshire. Wessex Archaeology undertook the initial excavation in collaboration with conservators from the British Museum, and the vessels were lifted in large soil blocks. The vessels were excavated from their soil blocks at the British Museum between 2010 and 2014, following a delay as the objects were acquired through the Treasure process and external funding to complete the project was sought from the Leverhulme Trust.

The Chiseldon assemblage is unprecedented in many respects. It is the largest known single deposit of prehistoric cauldrons. Radiocarbon dates of two cattle skulls also placed in the hoard indicate it was deposited in the 4th or 3rd century BC. This date was much earlier than expected, extending the dating of Iron Age cauldrons back at least 100 years. Deposition coincided with a period of remodelling of hillforts in the Wessex region and occurred at a time when hoarding as a practice was otherwise hitherto almost unknown. This is one of only a very few deposits containing several objects decorated with Celtic art dating to the Middle Iron Age and is significant because we can be certain the decorated objects were all deposited at the same time. It is also a very rare example of the absolute dating of art from this period. Scientific investigation of their technology revealed the cauldrons were complicated to manufacture and sophisticated techniques such as quenching were used to make them. Examination of food residues adhering to the vessels showed they were used to prepare and serve both meat- and vegetable-based dishes, probably including stews, gruels and porridges. The vessels are thought to have been made and used primarily for feasting, so the capacity represented by the number found in the hoard indicates the potential within Middle Iron Age Wessex society to host feasts with many hundreds, if not thousands, of participants.

From the very outset this has been a collaborative project and the persistence of the finder, who was convinced of the find's significance, and the cooperation and enthusiasm of the landowner, farmer, local community, professional archaeologists and national institutions have all contributed to its success. It demonstrates very clearly the value of cooperation between archaeologists and metal detector users and the importance of the information that can be gained when finds that are initially metal detected are minimally disturbed and later explored through controlled excavation.

Chapter 1

Introduction

Jody Joy

This volume reports on the discovery, excavation and investigation of a hoard of 17 Iron Age cauldrons, and many other substantial fragments, discovered by a metal detector user in November 2004 in a field located in the parish of Chiseldon, Wiltshire. It is unprecedented to find so many complete prehistoric cauldrons together in a single deposit. Cauldrons are a prominent class of artefact but, until recently, there has been very little understanding of their function, dating or typology, with many discoveries being poorly recorded 19th-century finds. Owing to their large size and complicated manufacture, cauldrons have long been thought to be vessels especially made for the preparation and serving of food and drink at social gatherings on a scale larger than the household, most probably at feasts, but this interpretation is yet to be fully explored in terms of the necessary integrated evidence of manufacture, use and deposition context. The Chiseldon hoard provided an excellent opportunity to correct this situation with the excavation, conservation and scientific examination of such a large number of contemporary vessels, providing previously unknown information on manufacture, use and the context of deposition.

From the very outset this has been a collaborative project and the cooperation and enthusiasm of the finder, landowner, farmer, local community, professional archaeologists and national institutions have all contributed greatly to its success and completion through to publication, as has the generous funding provided by the Leverhulme Trust.

The discoveries and their significance

The hoard was discovered in November 2004 by Peter Hyams, a local metal detector user. Following its discovery and a subsequent trial excavation late in 2004, it was not until the summer of 2005 that the hoard was fully excavated by Wessex Archaeology. Working in difficult conditions, in close collaboration with conservators from the British Museum, the excavators revealed that the hoard was contained in a large circular pit, approximately 2m in diameter and 65cm deep from the base of the subsoil. Fieldwalking and geophysical survey of the area surrounding the location of the hoard were undertaken by Wessex Archaeology in 2010 as part of the ‘Celts and Romans in North Wiltshire Project’, a community project funded by the Heritage Lottery Fund. Geophysical survey revealed a concentration of probable pits and evidence for structures and field boundaries and enclosures located just to the north of the hoard. A possible pit circle, probably first constructed during the Late Neolithic, was also identified by the survey. Fieldwalking uncovered evidence for a Roman–British settlement in the area, but degraded pottery and animal remains accidentally incorporated into the backfill of the hoard pit indicate there was probably a nearby Iron Age settlement occupied at the time the hoard was deposited.

The vessels were excavated from their soil blocks at the British Museum between 2010 and 2014, supported by funding from the Leverhulme Trust. Although it took some time for the project to be realised, the discoveries made following the excavation and scientific investigation of the

Chiseldon hoard have proved to be exceptional. When the cauldrons were first discovered, it was assumed – based on their form and type – that the hoard dated to the 2nd or 1st century BC. This soon proved to be wrong. Radiocarbon dating of the two cattle skulls also found in the pit showed they died some time in the 4th or 3rd century BC. Since the cattle skulls appeared to be relatively fresh and the pit the hoard was buried in was a closed deposit filled in one episode, it was concluded that cauldrons of the type found at Chiseldon must have been in use and circulation up to two centuries earlier than previously thought. The dating of the hoard to the 4th or 3rd century BC placed its deposition within an entirely different social context, with social hierarchies in Middle Iron Age Wessex thought to have been relatively flat. The deposition of the hoard also coincided with a period when some hillforts in Wessex were being remodelled and was a time when hoarding is otherwise almost unknown.

Possibly the most surprising discovery to have been made was the inclusion in the deposit of decorated vessels. Cauldrons are rarely decorated and the Chiseldon hoard is one of only a very few deposits containing several objects decorated with so-called Celtic art and dating to the Middle Iron Age, putting it on a par with finds from Fiskerton and Llyn Cerrig Bach in Britain and La Tène on the Continent. The Chiseldon hoard is also a very rare instance of the absolute dating of Celtic art from this period. The presence of two objects in the hoard decorated in the Vegetal Style adds significantly to the limited number of objects decorated in this style known from Britain and invites questions concerning contact with the Continent at this time. The discovery of mounts decorated in a bovine style, sharing its closest affinities with objects dated to the 1st century BC and 1st century AD, indicates that this bovine style of art has far earlier antecedents than previously anticipated.

It was noted during excavation that the metal the cauldrons were made from was in a poor state of preservation and initially there was pessimism as to how much information could be gleaned from technical and scientific examination of the metal. But fortunately for the investigation, details of manufacture such as marking out lines and hammer marks were preserved, facilitating meticulous reconstruction of how the cauldrons were made. Scientific examination of the metals also revealed the use of sophisticated metalworking techniques, such as quenching of iron components, and technical details concerning the construction of bronze sheet, which in some instances is incredibly thin.

A further unanticipated discovery was the preservation of food residues. Hitherto, food residues have rarely been found on prehistoric metal vessels. Examination of these residues showed that the cauldrons were used to prepare and serve both meat- and vegetable-based dishes, probably including stews, gruels and porridges. As there is limited evidence for bowls and other utensils, it is argued that the Chiseldon hoard was symbolically representative of a large feast, or series of feasts, rather than comprising all of the physical remains from a single event. Nevertheless, the large number of cauldrons deposited in the pit highlights the societal potential during the Middle Iron Age in southern Britain for

hosting large gatherings of hundreds, if not thousands, of people: a capacity on a par with anything discovered from prehistoric Europe.

The hoard may have been deposited at Chiseldon because it was a location of long-standing significance and/or it was a convenient gathering point. Placing so many cauldrons in one deposit perhaps brought a significant event or series of events to a close. The cauldrons were made by skilled craftspeople but they were not specialist cauldron makers. Based on evidence from the Chiseldon hoard, an alternative model for the production of complicated metal artefacts (some with decoration) is proposed: a ritual mode of production driven by feasting. In a largely non-hierarchical society such as Middle Iron Age Wiltshire, it is argued that social goals were achieved through compromise, building of consensus and developing solid and enduring interpersonal relationships, sometimes over large distances (see DeMarrais 2013, 346). Tantalising references in the early medieval Irish and Welsh vernacular literature suggest cauldrons may have been imbued with magical properties and had important social roles (Green 1998). Archaeological evidence provided by the Chiseldon hoard demonstrates that feasting offered a forum for the maintenance and development of relationships and cauldrons were important mediators in the feasting cycle. Through their manufacture, use and deposition, valuable social discourses were acted out.

A unique set of challenges

The hoard offered an extraordinary opportunity to investigate multiple contemporary objects but it also presented a unique set of challenges. The circumstances of the discovery and initial investigation meant that unfortunately much of the hoard was disturbed before full excavation could take place. This not only affected how the excavation could proceed but also had knock-on effects for all of the subsequent stages of the investigation, not least in terms of understanding the exact layout and position of the cauldrons in the hoard pit. The rural location of the site and its limited access also meant that it was not possible to block lift the entire hoard for later excavation under laboratory conditions as would have been ideal; instead individual cauldrons were lifted in separate blocks, further complicating the task of later reconstructing the layout of the hoard. Once the excavation was completed, because the hoard fell under the 2002 Designation Order of the Treasure Act (1996), the material remained in its lifted state until the Treasure process had been completed. As the finder disputed the valuation of the hoard, it was not until 2007 that the British Museum was able to acquire the objects. Owing to the fact that the conservation and scientific investigation of the remains of what was thought then to be 12 cauldrons (but later turned out to be 17) was far beyond the normal capacity of the British Museum, the project was again delayed as external funding was sought to start the investigation. Eventually, funding was successfully obtained from the Leverhulme Trust and in 2010 work started on excavating and conserving the hoard, six years after its first discovery. By this stage, the soil surrounding the cauldrons had dried out, creating further difficulties. The fragility and level of corrosion of the metal, the hardness of the soil and the

greater than anticipated number of vessels in the hoard all meant that excavation of the objects from their soil blocks took almost twice as long as originally anticipated. To try and meet some of these challenges with limited resources necessarily involved innovation and flexibility, particularly in terms of conservation techniques and by embracing new technologies such as high-resolution CT scanning.

Although many of the difficulties we encountered were peculiar to the Chiseldon hoard, questions surrounding how museums deal with large Treasure finds, or problems concerning the securing of funding and staff time to excavate and investigate large quantities of block-lifted material from excavations, are not (Hadley *et al.* 2010). The value of cooperation between archaeologists and metal detector users and the importance of the information that can be gained when finds that are initially metal detected are minimally disturbed and later explored through controlled excavation are clearly demonstrated by the Chiseldon project. So is the wealth of information gained by excavating block-lifted material under laboratory conditions. But, when set against the challenges this presents in terms of staff time and cost, the project also raises important questions concerning the allocation of resources for the investigation of unprecedented or unexpected discoveries made by metal detector users, which have the potential to tell us so much about past societies. This investigation is therefore not simply of relevance to those

interested in prehistoric objects and technology, but is also a case study of a specific type of archaeological investigation that is the product of current legislation in England and the challenges of processing archaeological block-lifted material.

The structure and arrangement of the report

This volume is divided into two parts. The rest of Part I describes the excavation, conservation, analysis and discussion of the hoard and its contents. Part II contains a Catalogue of the finds and the Appendices. The volume represents the work of many individuals. It was edited by Alexandra Baldwin and Jody Joy, who were responsible for the structure and format of the report and who respectively led the conservation and coordinated the project to excavate and investigate the contents of the hoard. Any uncredited sections of text were written by Baldwin and Joy.

Archive

Copies of the site archive and all of the objects from the hoard are held at the Departments of Conservation and Scientific Research, and Britain Europe and Prehistory at the British Museum. Details of the objects can also be accessed online via the British Museum's Collections Online database (http://www.britishmuseum.org/research/collection_online/search.aspx).

Chapter 2

Discovery and Setting of the Hoard

A.P. Fitzpatrick

With contributions by
John Winterburn, Jody Joy,
Ben Urmston, Allison Kerns
and Rachael Seager Smith

Discovery, identification and acquisition of the hoard

The hoard was found by metal detector user Peter Hyams in November 2004 in a ploughed field near the village of Chiseldon which he had searched many times before.

Alerted by the signal to the presence of a metal object, he excavated a small sondage to a depth of almost 1m where he discovered what appeared to be an iron vessel in a fragile condition which was accompanied by some fragments of sheet bronze. It was the beginning of a story full of twists and turns.

Peter Hyams posted a request for help with the find on the Britarch email list and received only what might be politely described as an unhelpful response. Fortunately, he was undeterred by this. He continued to seek advice and was rewarded when John Winterburn, a local archaeologist, got in touch largely because the find was described as being in north Wiltshire. It was only later that he discovered it was from Chiseldon, where he lives (**Fig. 1**).

Trial excavation

with John Winterburn

After a rapid exploration by John Winterburn and Peter Hyams in early November 2004 revealed what looked like a rusty bucket (**Fig. 2**), it was apparent that further work was required and this was organised with the help of the Chiseldon Local History Society. In sodden conditions on 18 November 2004, the ploughsoil was removed from an area 2.5m square around the original sondage. A rectangular area $c. 1.7 \times 1.5$ m was then excavated to the base of the ploughsoil (**Fig. 3**). This revealed what might have been up to three vessels, a plethora of sheet bronze fragments and some iron rings, all lying within what appeared to be a pit cut into the chalk. Realising that the fragile finds would require complex excavation, preferably with a conservator present, John Winterburn persuaded a reluctant Peter Hyams that the work should stop and that the find should be covered over. Two days later, despite having to work in a snowstorm, the excavation was packed with bubble wrap, polystyrene blocks and polythene and then covered by wooden boards.

Katie Hinds, the Portable Antiquities Scheme Finds Liaison Officer for Wiltshire, had visited the work and she retained some of the fragments of sheet bronze. Her consultations with colleagues from the Portable Antiquities Scheme and in museums did not yield a consensus as to their date. As it seemed possible that the vessels were of iron with bronze cladding, a prehistoric date was rejected. As their date remained uncertain, it was not clear what the next step, if any, should be, although a subsequent geophysical survey of the area around the find undertaken by Dr Colin Shell of Cambridge University did indicate an anomaly consistent with a hoard of metal objects (G. Swanton pers. comm.).

Further investigations

with Jody Joy

Peter Hyams then took matters into his own hands. He had seen the archaeometallurgist Peter Northover on a television programme and he contacted him at the University of Oxford to ask if he would examine some fragments of bronze. At this stage it was thought that the vessel might be

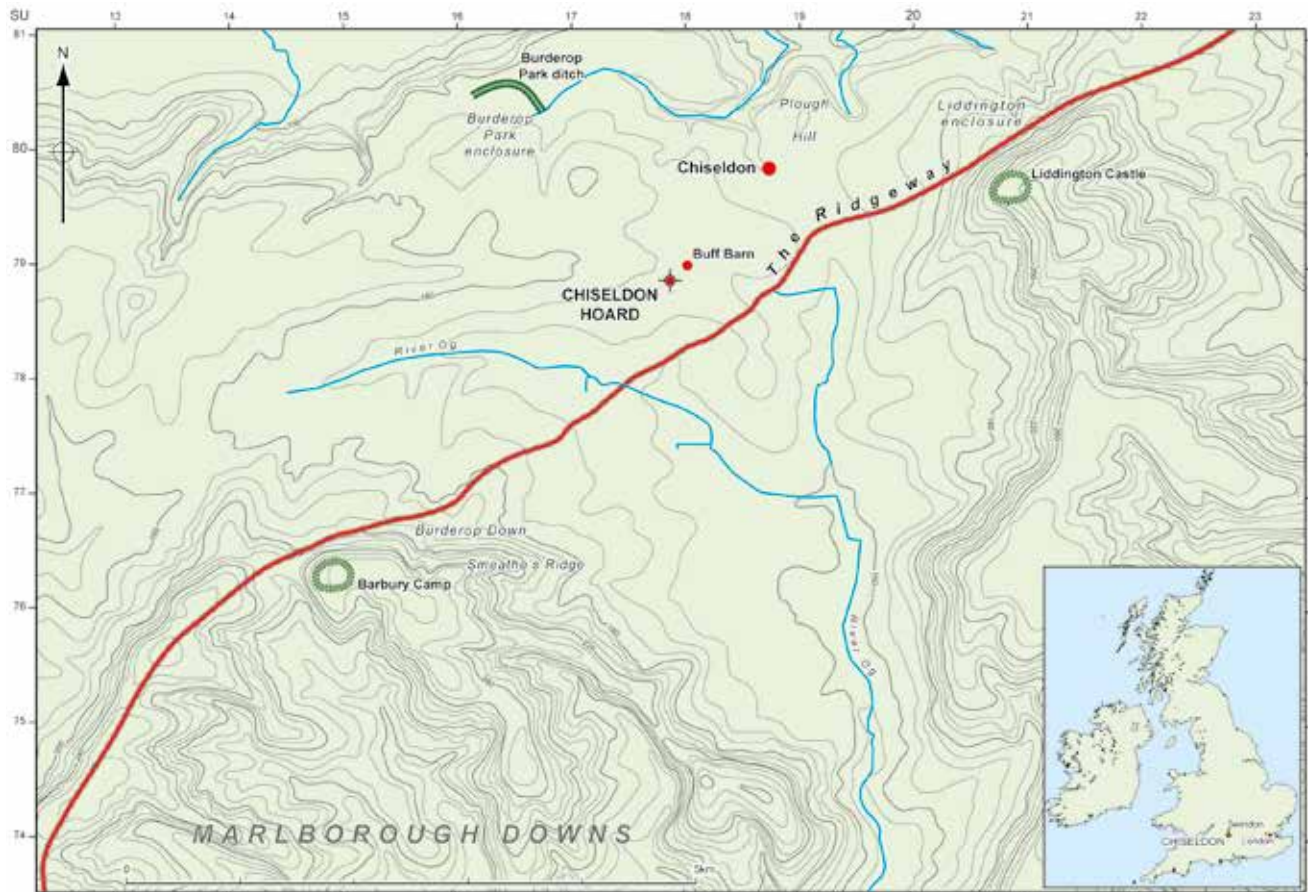


Figure 1 Location of Chiseldon and surrounding sites mentioned in the text

Anglo-Saxon in date but, unbeknown to Peter Hyams, Peter Northover had extensively researched prehistoric metallurgy, including sheet bronze vessels of Iron Age date (Northover in Gerloff 2010). In May 2005 a preliminary examination of the manufacturing techniques and the rivet holes that had once held repair patches suggested that the vessels were of sheet bronze and probably of prehistoric date. This was confirmed by metallurgical analysis (by electron probe microanalysis with wavelength dispersive spectrometry).

Northover's report is included in full as Appendix A. He found there were two broad matches for the metal composition. One was in the Middle Bronze Age in southwest England, mainly in Cornwall and Devon, but sheet bronze vessels were not manufactured at this time. The other match was in alloys found over much of central southern and western England and Wales in the Middle Iron Age, mainly during the 4th to 2nd centuries BC. The corrosion and the microstructure of the fragments were also consistent with other examples of sheet bronze of an Iron Age date examined by Peter Northover. The bronze at least seemed likely to be Iron Age in date.

On learning this from Peter Hyams, and knowing that the finds would be regarded as Treasure under the 2002 Designation Order for the 1996 Treasure Act, Katie Hinds approached Wessex Archaeology to undertake further investigations of the deposit. Wessex Archaeology had previously helped the Portable Antiquities Scheme with the examination of the find spots of a number of Treasure cases. The British Museum also agreed to send two conservators,

Alexandra Baldwin and Simon Dove, to be responsible for the on-site conservation. However, although the likely date of the bronze was relayed, at the start of the excavation it was still thought that the vessels were primarily made of iron, which would be most unusual for prehistoric vessels.

The excavation was undertaken in two stages in June and July 2005. Immediately after the excavation, the cauldrons were taken to the offices of Wessex Archaeology in Salisbury and then to the Wiltshire Conservation Laboratory, then at the Salisbury and South Wiltshire Museum, before being transferred to the British Museum.

For a variety of reasons there was then a lengthy gap in proceedings. Initially there was a considerable delay before a Treasure Inquest could be convened. It was eventually held in June 2006, and almost a year after the excavations, the hoard was declared to be Treasure under the Treasure Act. The valuation of the reward, which is payable under the Treasure Act and which is divided equally between the landowner and finder, is set by the independent Treasure Valuation Committee. In December 2006 the valuation of the hoard was set at £800 and the finder twice appealed unsuccessfully against this sum. As the British Museum could only acquire legal title to the hoard once the reward had been paid, this acquisition did not take place until the spring of 2007. It was then necessary to secure the funds for the extensive conservation, analysis and research required. A pilot conservation study was necessary to allow an accurate estimate to be calculated of the time needed to finish the study – a period of two years – and once this was completed the Leverhulme Trust awarded the Museum a



Figure 2 The hoard as first revealed (photograph: John Winterburn)



Figure 3 The trial excavation, viewed from the north (photograph: John Winterburn)

grant in March 2010. The Heritage Lottery Fund also awarded a grant to Wessex Archaeology in May 2010 for the ‘Celts and Romans in North Wiltshire’ project which involved some small-scale fieldwork at the find spot, which is reported on below.

The setting of the hoard

The hoard was found at SU 17875 78872, *c.* 1km southwest of the village of Chiseldon which is 6km south of Swindon in the county of Wiltshire (**Fig. 1**). The find spot lies at 175m above Ordnance Datum on the gently undulating land below the Marlborough and Lambourne Downs. The soils are the brown rendzinas of the 343h (Andover 1) and 343i (Andover 2) association (Soil Survey of England and Wales 1983).

Today, the place where the hoard was buried is overlooked, as it was in the Iron Age, by at least two hillforts, but the immediate archaeological context of the hoard is not clear. In the excavation described below it seemed likely that the pit containing the hoard, which contained settlement debris, had cut through one or more earlier, but otherwise undated, prehistoric pits. Subsequently small geophysical and fieldwalking surveys were undertaken to try to provide more information. While this did reveal evidence for a settlement, it appears to date mainly to the Roman period.

The local Iron Age context

The forts at Barbury Castle and Liddington Castle stand either side of the valley of the River Og which flows to the



Figure 4 Aerial photograph of Barbury Castle viewed from the northwest (© Crown copyright, Historic England Archive)

east of Chiseldon, and are part of the 'Ridgeway Group' of hillforts that stud the Marlborough and Lambourne Downs. Most of these forts are sited on the chalk escarpment but a third possible fort near Chiseldon, which is known only from aerial photography, is located on lower ground just to the east of the village of Chiseldon. All three of these forts (Barbury Castle, Liddington Castle and Chiseldon) overlook the junction between the River Og and the chalk escarpment. From there, there was easy access to the Thames Valley to the north and to the chalk massif of the Marlborough Downs. Other forts in the Ridgeway Group include Alfred's Castle, Uffington Castle and Segsbury Camp to the east of Chiseldon on the north Berkshire (or Lambourne) Downs, and these are the best-researched sites in the group (Miles *et al.* 2003; Lock *et al.* 2005). In contrast, comparatively little is known about the two or three hillforts near Chiseldon.

Liddington Castle (SU 209 797) is a 3 hectare (7.4 acre) univallate contour fort which stands at 275m aOD on the east side of the Og valley. The hillfort probably originally had two entrances, one of which was subsequently blocked. Finds recovered during quarrying between 1896 and 1899 included Late Bronze Age and Iron Age pottery (Passmore 1914, 578, 580, 583–4, pl. i) and limited excavation, primarily directed towards locating the site of the Anglo-Saxon Battle of Badon (Hirst and Rahtz 1996), suggested that the first defences were built in the Earliest Iron Age, perhaps in the 7th–6th centuries BC. This original timber revetted rampart was succeeded by a dump-type rampart in the 5th–4th centuries BC. There is some evidence for a later heightening of the rampart but when this was done is not clear. Although

excavation at Liddington Castle has been limited, detailed earthwork and geophysical surveys have been undertaken, revealing pits, some probable round houses and parts of ditched enclosures as well as other features. The scale of this activity is not as intense as that seen at some other sites, for example Barbury Castle nearby and Danebury, Hampshire, leading to the suggestion that the fort was not used intensively or for a very long period. As no pottery has been found at Liddington which date to later than the 5th century BC it has been suggested that the fort may have been abandoned at that time (Payne *et al.* 2006, 111–18, figs 2.51–6 and cover).

Barbury Castle (SU 149 765) (**Fig. 4**) stands at a height of 265m OD on the west side of the Og valley, 7km from Liddington Castle. It is a multivallate hillfort that encloses an area of 5 hectares (12.4 acres) and has opposed entrances at the east and west. Liddington Castle is visible from Barbury, as is the fort of Martinsell Hill well to the south on the southern escarpment of the Marlborough Downs and overlooking the Vale of Pewsey. No formal excavation has taken place at Barbury Castle but pits revealed in military works during the Second World War contained pottery of Early and Middle Iron Age date (Meyrick 1947, 260–2, figs iii, 3–4). No Late Iron Age pottery has been found and although a large hoard of metalwork found in or near to the fort before 1875 was initially suggested to date to the 2nd or 1st century BC (MacGregor and Simpson 1963), it has been suggested subsequently that the hoard dates to the 1st century AD (Manning 1972, 231), or even the Late Roman period (Bowden 2005, 159).

Barbury Castle has also been the subject of detailed earthwork and geophysical survey which revealed many pits

and circular structures, showing that the hillfort was densely occupied (Payne *et al.* 2006, 98–103, figs 2.42–5). On this basis the fort has been regarded as a classic example of a Middle Iron Age ‘developed hillfort’ of the type best known through excavation at Danebury (Payne *et al.* 2006, 99). The apparent absence of Late Iron Age pottery from the site would be consistent with the evidence from some other developed hillforts in Wessex which appear to have been abandoned in the 1st century BC.

The third fort, at Plough Hill, Chiseldon, was only recently identified by aerial photography in an aerial survey of the environs of Liddington (Bowden 2005; Payne *et al.* 2006). The site (SU 1901 8023) is 2km west of Liddington Castle, which overlooks it. Only part of the large univallate enclosure at Plough Hill is visible but it encloses an area of at least 8 hectares (about 20 acres) on the lower tier of the northern escarpment of the Marlborough Downs. One entrance is visible; it is slightly offset and this may indicate a date in the Late Bronze Age or Early Iron Age (Bowden 2005, 158; Payne *et al.* 2006, 113, fig. 2.52).

Non-hillfort Iron Age settlement in the Chiseldon area is less well known but the same air photographic survey also identified a smaller, though still substantial, enclosure at the foot of the northern escarpment below Liddington Castle and 0.5km to the north of it (SU 2058 8016) (Bowden 2005, 158; Payne *et al.* 2006, 114). The oval enclosure is 2.5 hectares (6 acres) in size and appears to have two palisade trenches. A number of Iron Age enclosures with double palisades are known in Wessex at Boscombe Down West and Coombe Down South, Wiltshire (Richardson 1951, 133–5, fig. 1, pls iv–v; McOmish *et al.* 2002, 155; Fulford *et al.* 2006, 32–41, figs 3.1, 3.9 and 7.2) and phase 2 at Suddern Farm, c. 5km west of Danebury (Cunliffe and Poole 2000a, 21, 199–201, fig. 3.49). The Boscombe Down and Suddern Farm settlements were occupied during the 1st centuries BC and AD, but the Coombe Down enclosure is earlier.

Otherwise there is little evidence for Iron Age settlement in the immediate vicinity of Chiseldon (see **Fig. 1**). What was initially thought to be Early Iron Age pottery found in the area of an earthwork enclosure at Burderop Park (Meyrick 1956; Grinsell 1957, 56) may instead be Late Bronze Age in date (Swanton 1987, 17, no. 231). The pottery and animal bone found in the ditch of a disc barrow and suggested to be Iron Age (Passmore 1927, 242) has also been re-dated to the Middle–Late Bronze Age and renamed as Burderop Down (Gingell 1992, 39, fig. 25). Evidence for Iron Age settlement in the vicinity of the Chiseldon hoard is currently limited to an isolated length of enclosure ditch, probably of Iron Age date, found c. 1km away at Burderop Park in 1977, and stray finds.

Although there are extensive and well-preserved Celtic field systems on the slopes below Barbury Castle to the east and southeast at Burderop Down (SU 1673 7642; extending south to Smeathe’s Ridge to the southeast [SU 1663 7601]), most of the finds recovered from the fields are Romano-British in date (Grinsell 1957, 274, no. F, 54; Swanton 1987; Gingell 1992, 155–7, fig. 96). Such field systems certainly should not be assumed to date to the Iron Age. Some may be Bronze Age but many will be Roman (cf. Bowden 2005, 156).

However, the excavations that have taken place in advance of the more recent northern expansion of Swindon, c. 10km to the north, may give a more accurate impression of the variety of Iron Age settlement that possibly existed around Chiseldon. These excavations have yielded evidence for a series of settlements and field systems of Early, Middle and Late Iron Age date (Gingell 1982; Walker *et al.* 2001; Evans and Alexander 2009, 117, 119, 126, fig. 2; Powell 2010, 133–4, fig. 2; Brett and McSloy 2011, 105), which are typical of the range of Iron Age settlements, both enclosed and unenclosed, found in Wiltshire (McOmish 1989; Robinson 1997; McOmish 2001).

Geophysical survey with Ben Urmston

A detailed gradiometer survey was undertaken of 2 hectares (5 acres) around the site of the hoard as part of the community project ‘Celts and Romans in North Wiltshire’. The survey was centred on the hoard and divided into two areas, either side of the field boundary that runs east–west immediately to the south of the find spot (**Fig. 5**).

Methods

The survey used a Bartington Grad 601-2 dual gradiometer system and was done in December 2010 in sub-zero temperatures and on frozen ground, though these conditions did not affect the quality of the data. Individual survey grid nodes were established at 30m intervals using a Leica Viva RTK GNSS system with a sample interval of 0.25m along transects 1m apart. This results in 3,600 logged values per complete grid. Data were collected in the zigzag manner with a sensitivity of 0.03nT, comparable with caesium vapour instruments.

Data from the survey were subject to minimal data correction processes. These comprised a zero-mean traverse function ($\pm 3nT$ thresholds) applied to correct for any variation between the two Bartington sensors used, and a de-step function to account for variations in traverse position due to varying ground cover and topography. These two steps were applied to all survey areas, with no further data filtering or interpolation. Further details of the geophysical and survey equipment, methods and processing are described in Appendix B.

Results

The geophysical survey identified a number of anomalies of definite, probable and possible archaeological origins and the results are presented as greyscale and interpretation diagrams (**Figs 5–6**). Numerous ferrous anomalies are visible throughout the survey dataset and these have been presumed to be modern and are not referred to, unless they are considered relevant to the archaeological interpretation. It is possible that weaker archaeological anomalies may have been masked by these ferrous responses.

The data from Area A, to the north of the boundary, are dominated by a profusion of pit-like anomalies (4000). It is considered likely that the majority of these anomalies are archaeological in origin, although the lack of definite coherency to their distribution means that interpretation must be cautious. It is possible to discern some alignments

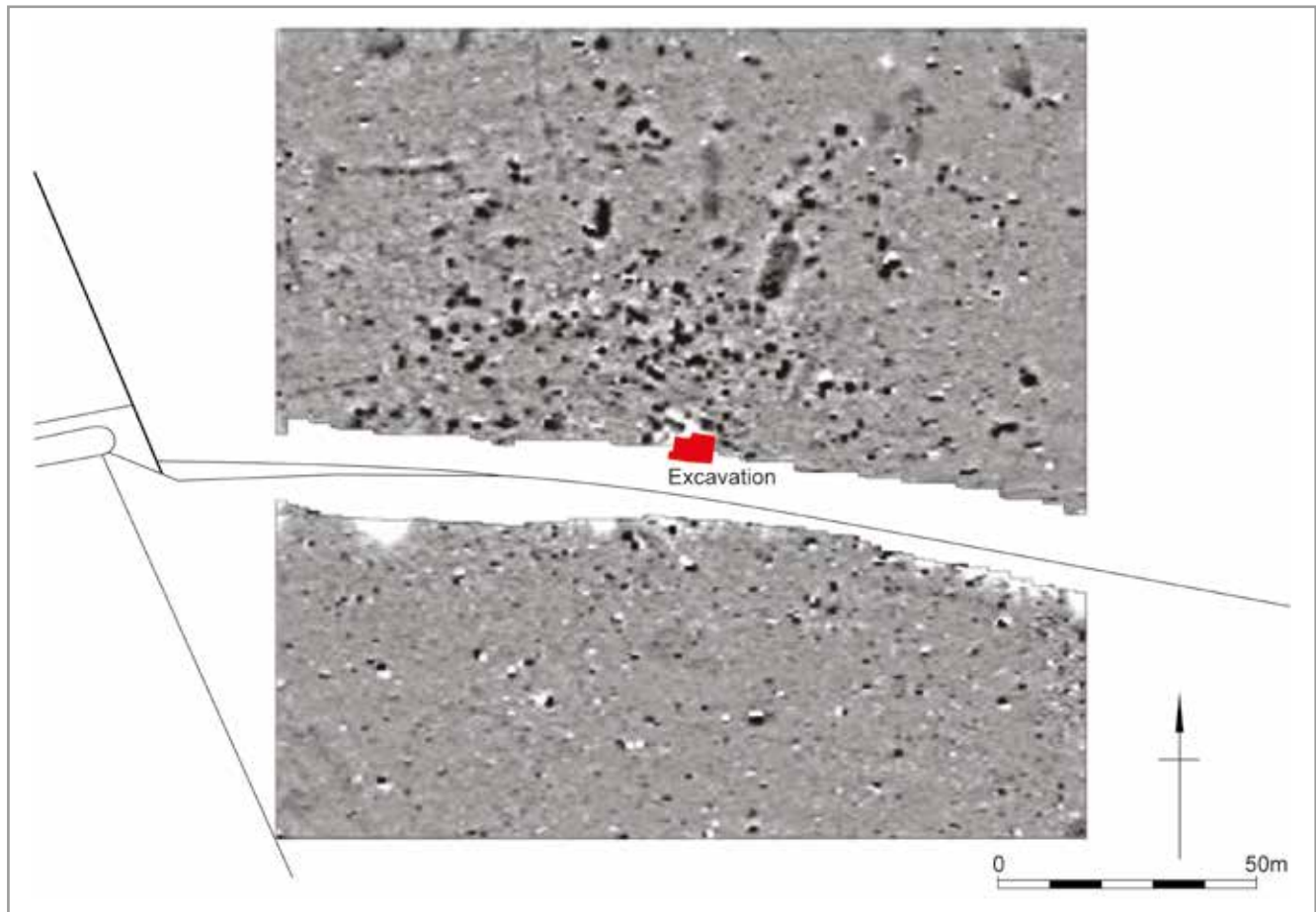


Figure 5 Geophysical survey: greyscale

within the distribution of the anomalies, but it is equally possible that these occur simply by chance as a result of the relative density of responses. Linear anomalies 4001, 4002 and 4003 are consistent with former field boundaries or enclosures. Their responses are relatively weak, suggesting that they have been at least partially ploughed out.

Several regions of increased magnetic response appear towards the northern extent of the survey area, with one lying to the west of 4002 and others at 4004–8. These anomalies are amorphous but show slight enhancement and have a different texture to the general magnetic background. It is possible that they indicate truncated archaeological deposits, although it is also possible that they reflect changes in the superficial geology.

The pit-like anomalies (4010) at the northern margins of the survey area seem to be distributed in an open group. It is not possible to discern such groupings elsewhere, particularly where the anomalies are densely packed. Two curvilinear trends extend from near the northwestern edge of the survey area, passing 4010 to the northeastern edge of the survey. The length of these trends suggests that they may represent a former track or boundary. Elsewhere in the dataset, numerous weak linear and curvilinear trends are apparent. It is possible that some of these are archaeological in origin, whereas others are more likely to be associated with ploughing.

In Area B a sub-annular anomaly some 25m in diameter (4009) appears near the southwestern extent of the survey area. This anomaly seems to be composed of discrete responses that form a circle and are consistent with the ditch

of a barrow or a pit circle. The pit-like responses north of the field boundary suggest that the anomaly produced by a barrow ditch should be of similar magnitude in this geological setting, lending credence to the interpretation of 4009 as a complex of individual anomalies such as a pit circle.

Conclusion

In Area A a dense concentration of pit-like anomalies (4000) was identified to the north of the hoard. It is likely that this indicates relatively widespread activity, which becomes more diffuse towards the northwestern and northeastern extents of the survey. It appears as though some of the smaller anomalies may form alignments and possible structures, though this would need to be confirmed by excavation. Linear anomalies 4001–2 are likely to be ditches, either field boundaries or enclosures, while a track or other boundary (4003–4) may also be present in the north of the survey area.

There is a marked change in the density of the pit-like anomalies to the south of the field boundary in Area B, suggesting that either the digging of the pits respected this boundary or that the boundary respects the probable settlement.

The penannular anomaly near the southwestern corner of the survey appears as an alignment of individual responses that form a near-perfect circle 25m in diameter. Given the relative magnetic magnitude of the pit-like anomalies 4000, it is thought that even a truncated barrow ditch would produce a magnetic response of greater

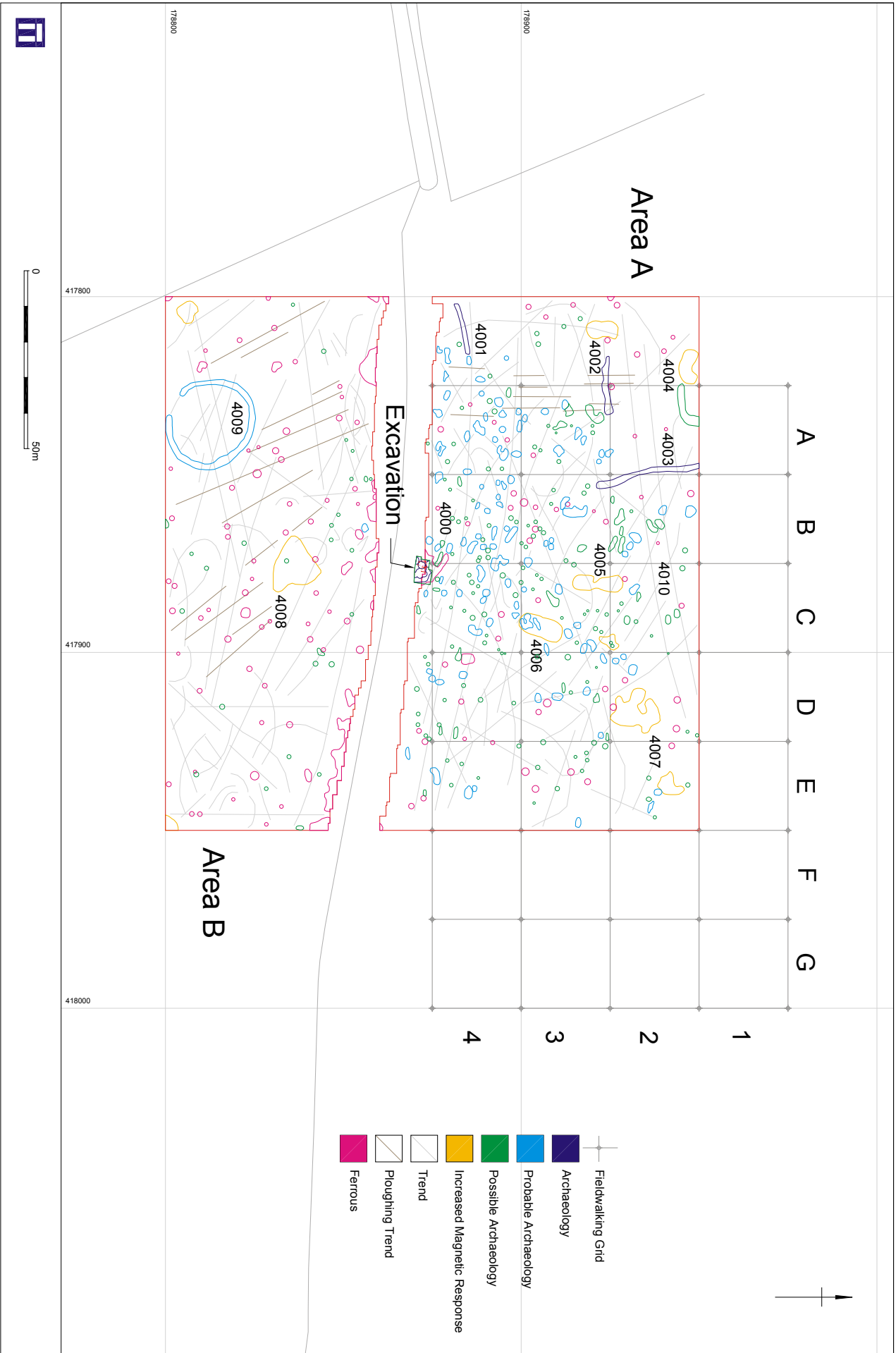


Figure 6 Geophysical survey, interpretive plot and location of fieldwalking grid in Area A

magnitude. It is therefore possible that it indicates the location of a different type of monument composed of individual elements, such as a pit or timber circle.

Several regions of increased magnetic response were also identified across the two survey areas. Such anomalies may be produced through the truncation of archaeological deposits or near-surface geological changes. Given the density of anomalies of probable archaeological origin nearby, it is possible that these areas of increased response represent areas of activity.

Fieldwalking survey

with Allison Kerns and Rachael Seager Smith

A small fieldwalking survey of the area to the north of the field boundary was also undertaken as part of the community project. It covered an area slightly larger than Area A of the geophysical survey (see **Fig. 6**). The finds were collected in 25m squares and although a consistent scatter of Roman pottery was found, no distinct concentrations of material were noted. The finds are summarised below; full details of all the identifications are held in archive at the British Museum.

Flint

A small quantity of flakes (16 in total) represents a general 'background noise' of prehistoric activity in the area. There are no tools or retouched flakes and none of the pieces are chronologically diagnostic.

Pottery

Some 1,441 sherds of pottery, predominantly Roman in date, and weighing approximately 13kg, were recovered. Most of the sherds were in relatively poor condition and showed the high levels of surface abrasion and edge damage typical of ploughsoil assemblages. With an average weight of just 9g, the mean sherd weight is low.

A small, plain body sherd in an undiagnostic sandy fabric was found in square G1. The sherd is likely to be Late Iron Age in date. Romano-British material dominated the assemblage, spanning the entire period, although the more diagnostic fabrics and forms indicate an emphasis on the later 3rd–4th centuries AD. Overall, the assemblage was dominated by local wares, supplemented by a few pieces of samian and other British regionally traded wares. The fabrics and forms are well paralleled among the pottery from

the nearby Roman 'small' town of Wanborough (Seager Smith 2001). A single medieval sherd and a small amount of modern material may derive from the practice of manuring the fields with domestic refuse.

Worked stone

Approximately 30% of a well-used upper rotary quern stone of sandstone was found in square B4. Typologically, this stone belongs within Curwen's Early Romano-British flat-topped group – stones with flat tops, small, circular hoppers, and low-angled grinding surfaces (Curwen 1937, 144, figs 15–18).

Ceramic building material

Six pieces of ceramic building material are also of Romano-British date. Three flat fragments are probably from tegula roof tiles (from squares A3, D2 and E3) and the other three (squares A2, G1 and G3) all have the combed keying typical of box-flue and voussoir blocks which were commonly used in hypocausts and in the construction of arches.

Discussion

The small quantity of prehistoric flint, most likely to be of Neolithic or Early Bronze Age date, may be related to activity associated with the possible pit circle or sub-annular gully (4009) in Area B. No evidence for Iron Age activity contemporary with the hoard was found and although this seems likely to be due, at least in part, to the poor survival of prehistoric pottery in the ploughsoil, it also suggests that an unknown number of the pits identified in the geophysical survey are Roman in date.

These finds are consistent with those from a Romano-British settlement 'north of Buff Barn' (see **Fig. 1**) which was found immediately to the east in 1974 (at SU 1795 7890; the recent survey was centred on SU 1787 7887). A fieldwalking survey undertaken by the Swindon Archaeological Society in that year found pottery of 2nd–4th century date, fragments of quern stones, sandstone roof tiles and sarsen stones (Anon. 1978, 135, no. 78). It seems likely that, despite the slightly different locations recorded, the two fieldwalking surveys have recorded the same site. The recovery of probable tegula and box-flue and voussoir blocks suggests the presence of at least one substantial Romano-British building in the vicinity.

Chapter 3

Excavation

Alexandra Baldwin and
A.P. Fitzpatrick

With contributions by
Andrew Armstrong and
Catherine McHarg

Account of the excavation

with Andrew Armstrong and Catherine McHarg

The excavation of the hoard started on 20 June 2005 with the expectation of recovering three vessels of unknown size, possibly iron. The recovery of the hoard was the principal objective of the excavation and it was anticipated that this would take two or three days. The topsoil over the trial excavation area was removed by hand and because of the better weather conditions it was now possible to see the outline of a pit cut into the chalk (**Fig. 7**). The excavation area was enlarged to a c. 5m square in order to fully expose the extent of the pit containing the finds (133) which was circular and c. 2m in diameter.

Several other features lay to the south and west of pit 133 (**Fig. 8**). Pit 140 lay to the south and was a discrete feature. Pit 133 appeared to cut pit 134 immediately to the west but the stratigraphic relationship could not be established with confidence. What was tentatively identified as pit 108 may be part of the same feature as 133. Pit 108 was only examined where it was necessary to cut back the side of pit 133 in order to create space in which to work, while pit 140 was planned but not excavated.

There may also have been other pits to the east of pit 133. Feature 146 was a shallow scoop 0.5m in diameter, and 0.15m deep, which was cut by pit 133. Pit or spread 144 was only examined to a depth of 0.07m to try and identify the stratigraphic relationship between it and 133, but when this could not be established excavation ceased. Other possible pits (recorded as 157) were also observed to the north and east of pit 133 when a mechanical excavator was used to cut an access ramp. These appeared to cut pit 134, which in turn may have been cut by pit 133.

Although these pits and other features are poorly defined, particularly those to the north and east of pit 133, they do suggest that there was earlier activity on the site. The date of this activity remains unknown as the focus of the work was firmly on the recovery of the metal vessels.



Figure 7 Reopening the trial excavation, viewed from the west (photograph: Wessex Archaeology)



Figure 8 Plan of pit 133 and adjacent features

In pit 133 the backfilled topsoil from the earlier trial excavation (100) was removed to expose the metal vessels in order to establish their size and condition. It was soon apparent that the vessels were primarily of sheet bronze and that the first sondage had exposed the base of cauldron 4 and parts of cauldrons 1, 2, 5 and 6. From this it was clear that there were more than three metal vessels in the pit. It also became apparent that what had initially been thought to be iron cladding was in fact the iron rim and collar used to strengthen the wafer-thin sheet bronze body and take the weight of iron rings from which the cauldrons were suspended during use. It also rapidly became apparent that the deposit was much larger and more complicated than had been anticipated.

One disadvantage of reopening the trial excavation was that the excavation essentially started by working outwards from a hole dug through the fill of the western part of the pit. However, it was soon apparent that the cauldrons exposed in November had deteriorated over the winter (largely because of the exposure of the finds to air and the change in water

permeation through the loose backfill and the packing material, which consisted of plastic and polystyrene) and that they needed to be stabilised and removed as quickly as possible to prevent further decay. Accordingly, the decision was made to excavate the western part of the pit first. The exposed cauldrons were excavated first followed by the remaining, western, parts of the pit.

All the soil from the pit, including the backfill of the trial excavation, was retained for sample processing. This soil was later wet-sieved through nested 4mm, 2mm and 1mm sieves. In the field, the topsoil was also carefully searched for finds by hand and with a metal detector. Whole cauldrons and loose parts of them were allocated individual small find (SF) numbers and their locations were recorded in three dimensions. These numbers have been retained throughout the conservation and analysis of the cauldrons (tables associating the SF numbers with each vessel can be found in the catalogue entries). Individual soil samples were also taken from around and below the cauldrons. These were primarily taken for finds recovery but for convenience they

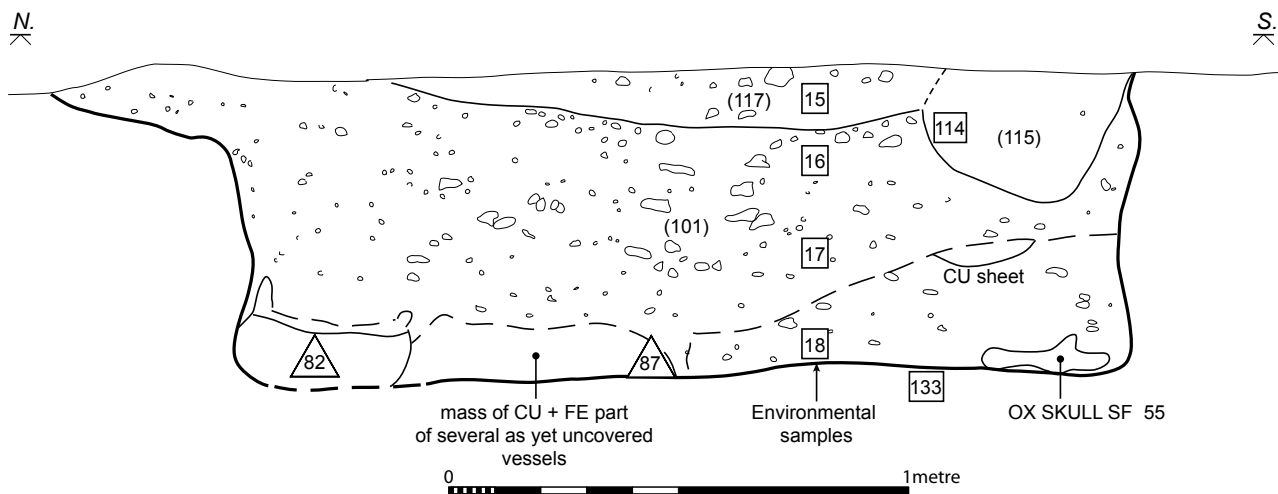


Figure 9 West-facing section of pit 133

were allocated environmental sample numbers and were processed so as to allow for the recovery of any charred remains. As the method of excavation meant that the pit was effectively being half-sectioned, the west-facing profile was recorded (**Fig. 9**). Samples for pollen were taken from this section but they were not processed when it became apparent that the pit had been deliberately backfilled and it was considered that there was little prospect of any pollen that was originally present having survived in the free-draining chalky fill of the pit.

As finally revealed, the pit (133) was circular, 2.0m in diameter and 0.65m deep from the base of the subsoil. It was cut into the natural chalk (142) and originally it was probably *c.* 1m deep from the ancient ground surface. There was no evidence that the pit was lined. The pit appeared to have been infilled with a single homogeneous fill (101) (**Fig. 9**). This was a very dark brown clay loam that contained occasional small- to medium-sized chalk lumps and occasional small- to medium-sized lumps of sub-angular flint. It contained a few small fragments of Middle Iron Age pottery (4th–3rd centuries BC), occasional small pieces of animal bone, charcoal and charred plant remains and a few pieces of burnt

stone. The lower part of fill 101 was slightly paler and for this reason it was tentatively identified as a separate fill (103) but otherwise there was no discernible difference. The different colour may relate to the straw that was recognised subsequently in the micro-excavation of the cauldrons (Chapter 10).

At the top of the fill sequence in pit 133, and at the centre of the pit, was a dark brown clay loam (117) fill that contained large chalk lumps and fragments of pottery and bone. This fill was *c.* 0.15m deep but only *c.* 1.2m in diameter compared to the *c.* 2m diameter of the pit. It may represent the deliberate levelling of the surface of pit 133 after its fill had slumped. A small pit (pit 114), 0.4m in diameter and 0.3m deep, had been cut into the southern edge of fill 117 and into the top of the main fill of the pit, 101. Pit 114 did not cut down to the level of the cauldrons and as its fill was very similar to the main fill of the pit (101) it may have been an animal burrow.

The western half of pit 133 proved to be filled with large cauldrons, including vessels 1, 2, 3, 4, 5, 6 and 7 and a large section of copper alloy cauldron fragment 18, which were badly corroded and fragile (**Fig. 10**). This created very cramped and difficult working conditions (**Fig. 11**). Next to



Figure 10 The cauldrons in the western part of pit 133 in the first part of the excavation, viewed from the north. Scale 1m (photograph: Wessex Archaeology)



Figure 11 Cramped working conditions during the excavation of the western part of pit 133, viewed from the north (photograph: Wessex Archaeology)

cauldron 3 on the base of the pit on the southern side was a complete cattle skull, SF55. It had been placed in the pit upright. Cauldron 8, most of which lay in the eastern part of the pit, was only identified when cauldrons 5 and 6 were removed.

After the careful removal of the soil around them (**Fig. 12**), the cauldrons were stabilised by conservators Alexandra

Baldwin and Simon Dove (**Fig. 13**) (see Chapter 4 for lifting techniques). As far as possible the soil inside the cauldrons was left untouched, but in some cases the cauldrons had fused together and in order to remove them from the pit it was necessary to remove some of the soil that filled them. Where this was done the fills of the cauldrons were recorded as separate samples. In such a small space and with the soil and cauldron blocks weighing up to 50kg, lifting the cauldrons was difficult and this sometimes required the side of the pit to be cut back into the undisturbed natural deposits. Eventually all the vessels were safely removed. The parts of further cauldrons in the eastern part of the pit that had been exposed in order to remove the cauldrons in the western part were also stabilised to prevent their deterioration.

As the excavation of the western part of the pit had taken twice as long as anticipated and as the excavators had prior commitments, a short break was necessary before work could start on the eastern part of the pit. In order to protect the find, the excavation was backfilled. When work recommenced three weeks later on 18 July, a mechanical excavator was used to create better working conditions. The excavation was extended to the east and ramps were created to make lifting the cauldrons easier. This also revealed the pit-like features (144, 146 and 157) discussed above. The excavation of the second half of the pit revealed a further four complete cauldrons 8, 9, 10 and 11 (**Figs 14–15**). At the southern side of the pit next to cauldron 10 was a second cattle skull, SF 117, which had been placed upside down (see **Fig. 15**).

Deposition and the contents of the pit

Order of deposition

The on-site excavation revealed 11 near-complete cauldrons, 5 additional significant sections of copper alloy which had been deposited as fragments, and 2 cattle skulls deliberately placed in the pit, with another 6 cauldrons discovered during conservation and excavation of the soil blocks. Most of the



Figure 12 Cauldron 2 (SF6) in situ, viewed from the southeast. Scale 200mm (photograph Wessex Archaeology)



Figure 13 Cauldron 9 being stabilised before lifting (photograph: Wessex Archaeology)



Figure 14 Cauldron 9 under excavation, viewed from the east (photograph: Wessex Archaeology)

Figure 15 Recording the eastern part of pit 133, viewed from the west. Note the upside down cattle skull SF117 to the right of the photograph (photograph: Wessex Archaeology)



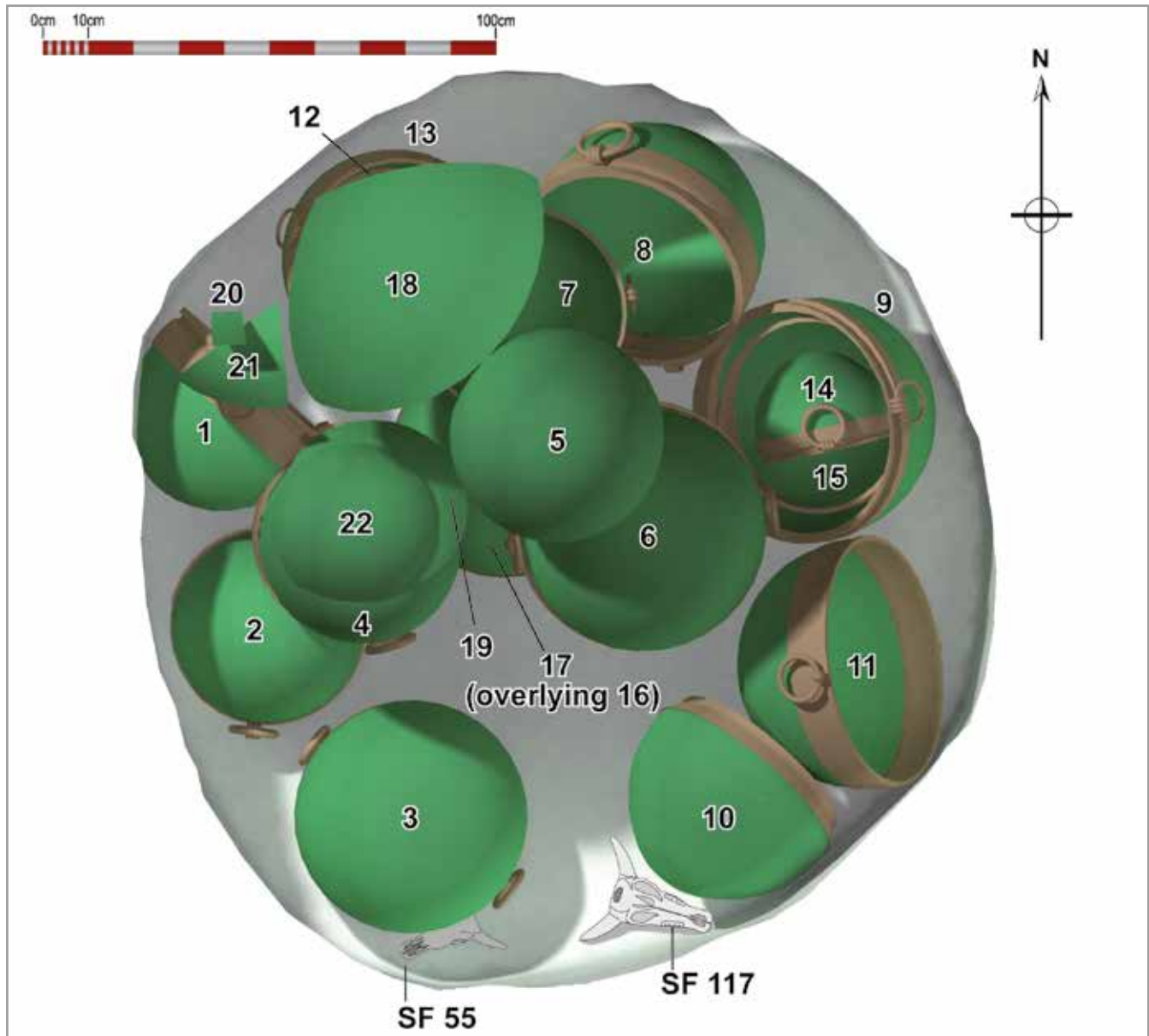


Figure 16 Reconstruction of cauldrons in pit 133

cauldrons had been placed around the wall of the pit in a penannular or horseshoe arrangement with the gap to the south. On either side of the gap, between cauldrons 10 and 3, were the two cattle skulls SF117 and SF55. In the northern section of the pit the cauldrons were stacked four deep. The position of the cauldrons can be seen in **Figure 16**.

While there is no stratigraphic relationship to demonstrate the sequence, general inferences can be made about the order of the cauldrons' deposition into the pit and these are described in **Figure 17**. The first layer of vessels placed onto the floor of the pit clockwise from the southwest includes cauldrons 3, 2, 1, 12 and 13 (cauldron 12 is fitted tightly within cauldron 13 and they were probably placed in the pit together), 8, 9 (with cauldrons 14 and 15 tightly packed within cauldron 9), 11 and the double cauldron stack of cauldrons 16 and 17 placed in the centre. Cauldron 10, the vessel immediately adjacent to 11 and at the southeast end of the horseshoe arrangement, was placed on the bottom of the pit with the rim resting against cauldron 11 at a 45-degree angle facing downwards. It is unlikely that cauldron 10 rolled or shifted position during backfilling and burial, and

it must therefore have been put into the pit after 11. The second phase of deposition includes: cauldron 7 placed offset above 12 and 13 and 8; and cauldron 6 placed over the 16/17 complex and a portion of the rim of 9 (also containing 14 and 15). Above this cluster a third layer of deposition consisted of: cauldron 4, placed above cauldron 6 and fragments 20 and 21; and cauldron 5 which covered the abutting rims of cauldrons 7, 6, and 8. Two further large copper alloy cauldron fragments were deposited in the last layer: fragment 19 above cauldron 4 in the centre of the pit; and fragment 18 which is directly on top of cauldrons 12 and 13, but also overlies the rim of cauldron 5 and therefore must have been one of the last objects placed into the pit. There is also some evidence for further copper alloy cauldron fragments placed above 19 and 4 (collectively referred to as fragment 22); however, this area was heavily disrupted by initial excavations and much of the evidence lost.

Orientation

The orientation of the cauldrons was hard to establish during excavation due to the distorted and flattened nature

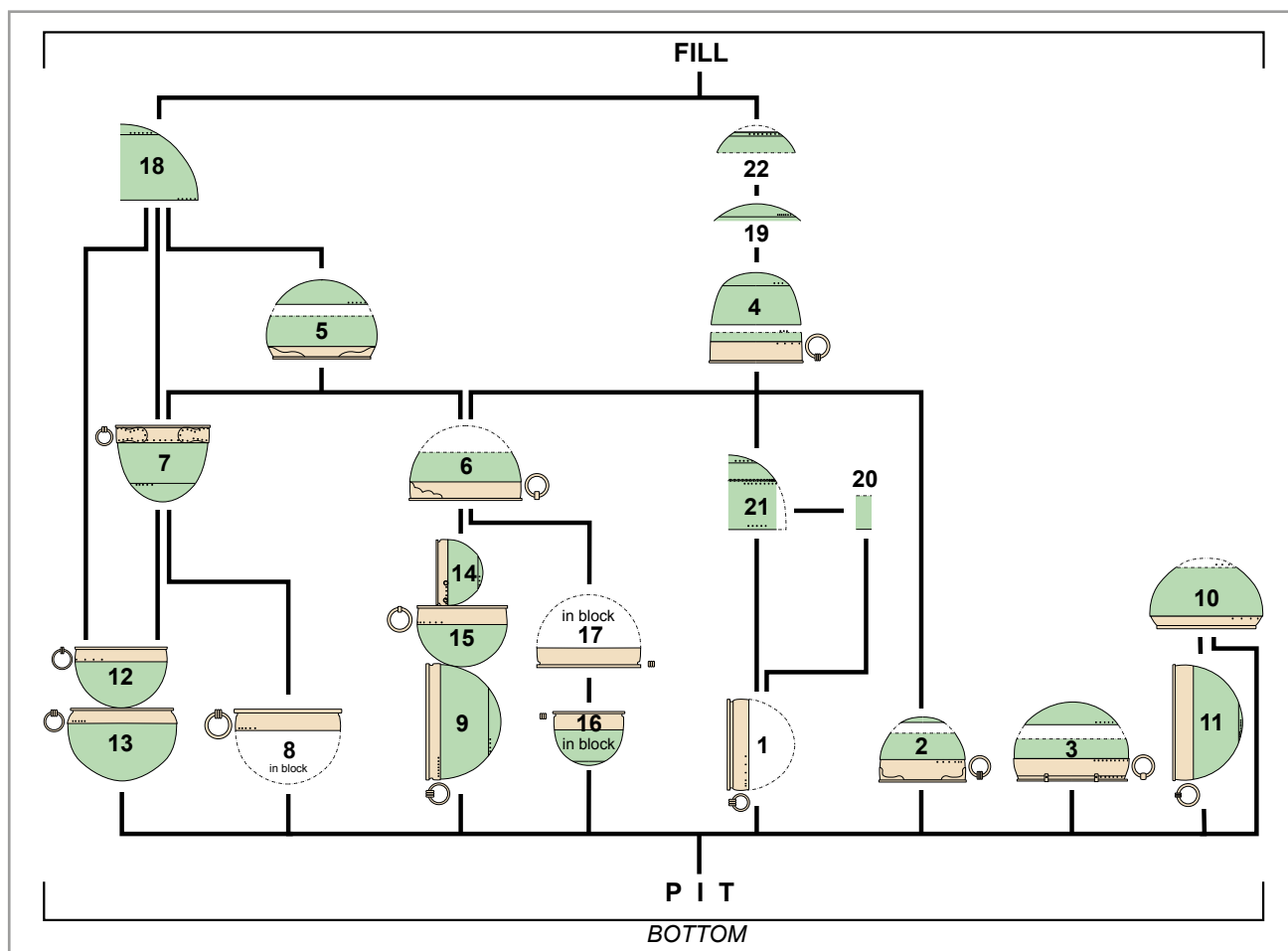


Figure 17 Deposition order of the vessels in the pit

of the objects, and has been revised as a result of conservation and further examination. Clockwise from the southwest: cauldrons 3, 2, 4, and fragment 22 were placed in the pit upside down; cauldron 1 was on its side under cauldron 4 with the mouth of the cauldron either to the east or southeast; cauldrons 12, 13, 7 and fragment 18 were all placed upright; cauldrons 5 and 6 were upside down.

Cauldron 16, at the bottom of the pit, was placed upright with cauldron 17 upside down directly above it. The cauldrons on the east side of the pit were on their side but it is possible that they were originally deposited upright and rolled due to the weight of the rims or during the backfilling of the pit. The mouths of both cauldrons 8 and 9 were tilted southwest towards the centre of the pit. Cauldrons 14 and 15



Figure 18 Cauldron 9 during micro-excavation with cauldrons 14 and 15 visible

were both found within cauldron 9 (**Fig. 18**). Cauldron 15 was upright and cauldron 14 was on its side within it, with the mouth of the cauldron to the southwest. At the southeast edge of the pit cauldron 11 was on its side but with the mouth of the cauldron facing east towards the edge of the pit. Cauldron 10 was also on its side but with its mouth facing down at a 45-degree angle with the base of cauldron 11 partially within it. The cattle skull SF55 on the west side of the pit had been placed the right way up although it was partly obscured by cauldron 3, while cattle skull SF117 to the east was upside down.

The hemispherical shape of the cauldrons together with the thinness and relatively flimsy construction of the bases would probably suggest that when not hanging the cauldrons would have been stored rim down to preserve their shape, and this practice may be reflected in the large number of cauldrons placed upside down within the pit. Additionally, with the exception of cauldrons 7 and 16, all the cauldrons placed upright in the pit were those containing other cauldrons nesting inside. And although there is scant evidence for object-related organic remains

(Chapter 10) it is possible that cauldrons 7 and 17 may have been placed upright because they contained feasting-related objects made of organic material which have not survived burial.

Mineralised organic remains of grass or cereal stems (discussed in further detail in Chapter 10) were preserved in substantial quantity on all the iron rims irrespective of the orientation of the cauldron. This indicates that the vessels were carefully packed within the pit and both laid on, and covered with, organic matter. Additionally, the position of some of the cauldron handles implies that there was a relatively soft material in the base of the pit into which the handles could naturally sink or be pushed. The handles of cauldron 3, for example, buried upside down, have fallen with gravity and are corroded in an extended position. Had the cauldrons been placed on a solid material, such as the pit floor, the handle would have corroded at 90 degrees to the upper iron band. The iron bands of nesting cauldrons 14 and 15 are also covered in organic material, indicating that there was packing material between the layers of nesting and stacked cauldrons.

Chapter 4

Conservation Techniques

Alexandra Baldwin

With contributions by
Hayley Bullock and Hazel
Gardiner

Lifting and on-site conservation methodology

Conservators Alexandra Baldwin and Simon Dove worked alongside archaeologists from Wessex Archaeology to provide advice and practical lifting expertise, which proved invaluable for what turned out to be a complex deposit. Without an on-site conservation presence, a full understanding of the deposit at the laboratory excavation stage would not have been possible, despite adequate excavation records and detailed plans and photographs.

The on-site conservation and lifting of the cauldrons were restricted by several factors, including the condition of the objects and the brief time frame of the rescue excavation. The cauldrons were densely packed into the pit and distorted by the weight of the overlying soil. The copper alloy and iron were highly corroded and, although appearing largely intact, were very fragile not only due to the thin nature of the metal, but also because the integrity of the metal was compromised by hairline cracks.

The ideal method for removing complex and object-dense features is to lift the entire deposit as a large block lift containing the artefacts and surrounding soil (Payton 1992; Sease 1992; 1995; Watkinson and Neal 1998). The size and nature of this deposit, with little soil around the objects to hold the block together, meant that it would have been very unstable. Such lifts require a large crate constructed around the block, the use of heavy lifting gear and a large flatbed truck. Additionally, the lack of vehicular access to the site combined with its rural location and the small size of the trench made this approach impossible. Where large block lifts have been attempted it has been on building sites where such equipment is readily available. This method was successfully used to lift a cauldron deposit from the late La Tène site at Basel-Gasfabrik, Switzerland in 2010 (Hüglin and Spichtig 2012). The large complex deposit containing two iron and copper alloy cauldrons as well as several ceramic vessels was lifted as a large block approximately 2m³ and an estimated 9 tonnes in weight (Sophie Hüglin and Janet Hawley pers. comm. 2010).

After careful consideration a compromise was reached and attempts were made to lift the Chiseldon vessels individually. Several methods of individual lifts using different materials have been suggested in the literature. For the lifting of metal, Sease (1995) recommends the use of bandage or scrim impregnated with a 15–20% solution of Paraloid B72 (ethyl methacrylate co-polymer) adhered directly to the object. The use of cotton bandages soaked with Paraloid B72 in acetone for the lifting and retrieval of a single copper alloy vessel has been carried out in the past but this was a single vessel of a smaller size, *c.* 30cm in diameter (Balboa *et al.* 2013). This method was dismissed due to the impracticalities of using large volumes of solvents in the close working conditions of the pit; for health and safety reasons, limiting the use of hazardous materials was desirable. Additionally, this method would not have worked well with the damp clay soil of the Chiseldon deposit. Instead it was decided to use a plaster bandage support over a cling film barrier layer. This method had been described extensively for the lifting of ceramic vessels (Payton 1992; Sease 1992; 1995; Watkinson and Neal 1998) and has the benefit of using cheap and readily available materials which have no solvent



Figure 19 The process of lifting the cauldrons: a) packing undercuts with wet acid-free tissue; b) cling film barrier layer; and c) plaster bandage applied to the block



Figure 20 Lifted cauldrons and associated small finds stored temporarily at one of the British Museum's outstations

base and yet are easily adaptable to collar lifting the cauldrons.

To achieve a collar lift, access around each object was required. Where this proved impossible, owing to the close proximity or overlapping of the objects, a decision was made to remove objects disturbed by the previous excavations first. Much of the conservation and excavation was carried out in tandem owing to the strict time frame of the excavation. Soil was removed from around the objects to reduce the weight of the individual blocks. Where areas of fragile copper alloy sheet had been exposed and were at risk of damage during the lifting process a facing was applied. Japanese tissue facings adhered with a solution of Vinamul 3252 (ethylene vinyl acetate co-polymer in a colloidal dispersion) were applied to exposed areas of fragile copper alloy sheet. Vinamul 3252 was chosen due to its ease of use, flexibility, and low toxicity; it is also compatible with a damp deposit. It was chosen above other water-based dispersions, such as Lascaux (Butyl acrylate/methyl methacrylate co-polymer), as the higher viscosity of the adhesive meant that it adhered the Japanese tissue to the metal and soil without penetration into the substrate. Additionally, it has a low shrinkage of less than 3% and a relatively stable pH of 6.2–5.1, although it has a low reversibility (Horie 1987; Parker 2005).

Undercuts, voids and unsupported areas were packed out with dampened acid-free tissue (Payton 1992; Liz Barham pers. comm.). The objects were wrapped in cling film which formed a barrier layer, and then encased in three to four layers of Gypsona plaster bandage. The process of lifting the cauldrons can be seen in **Figure 19**.

The blocks were then released from the underlying soil by hammering iron rods into the natural deposits below the base of the cauldrons. The blocks could then be slid along the rods and onto marine ply boards and lifted out of the pit. Bubble wrap and large sample bags filled with acid-free tissue balls were used as packing around the base of the cauldrons. Smaller detached fragments were packed in plastic seed trays, finds bags (grip seal polythene bags) and Stewart boxes lined with Plastazote or acid-free tissue.

A total of 15 complete cauldrons were lifted in seven blocks. Two more cauldrons were lifted in sections and approximately 130 smaller fragments from the soil were lifted as individual small finds (**Fig. 20**).

Conservation assessment

After excavation, the finds were moved to a store at one of the British Museum outstations for the duration of the Treasure and acquisition process. While it was understood that ideal conditions for the storage of the objects excavated from a damp, but not waterlogged, clay-rich soil would be a cool and damp environment, no facility large enough to store the volume of material could be found. It was decided to let the soil surrounding the objects dry out slowly to minimise stress cracking and contraction of the soil prior to placing them in a conditioned dry store. No interventive conservation work could be undertaken prior to Treasure valuation and acquisition; however, the material was sorted and checked against the small finds register, and regular condition checks and photographs were made to monitor the condition of the metal and the blocks.



Figure 21 Corrosion disrupting the surface of the copper alloy sheet of cauldron 14

After acquisition by the British Museum, the material was again assessed to determine condition, conservation priorities and time estimates for treatment. As the time required to treat such a large volume of material was hard to ascertain, some initial cleaning and X-radiography of fragments from the hoard was started in 2008.

X-radiography was carried out using a TORREX TRX 5200 system set at 3 mA and exposure levels of 100–130Kv for 1–10 minutes depending on the condition, thickness and type of metal. Agfa D4 film was used for the image capture with a lead backing sheet to reduce backscatter. A report on materials, equipment and resources for the conservation of the cauldrons, taking into account objectives and priorities for study and publication, was drafted and funding from the Leverhulme Trust was applied for.

Project parameters

The aim of conservation was to prepare the objects for study and publication. This prioritised the investigation of the deposit to reveal the technology used in the manufacture of the cauldrons, as well as the physical and chemical stabilisation of the objects. Reconstruction of the fragments was limited and only carried out to aid understanding of the vessels and to ensure that the fragments were safe to handle during photography and illustration. The conservation of the cauldrons was carried out over a period of seven years from 2007, when the objects were acquired by the Museum, to 2014. Four conservators – Alexandra Baldwin, Hayley Bullock, Hazel Gardiner and Jamie Hood – worked on the cauldrons at different times during this period. In total the work took approximately 6,320 conservator hours, more than double the original estimate of 3,120 hours. The increased amount of time taken to conserve the vessels was in large part due to the five additional cauldrons found during the micro-excavation of the blocks, with the number of cauldrons thereby increasing from 12 to 17, and the exceedingly poor condition of the objects. Owing to the unexpected fragility of the objects and the discovery of extra cauldrons in the deposit, the time spent on basic cleaning

and stabilisation increased, while the level of conservation undertaken on each cauldron was not as extensive as originally planned. Further work on the objects would be required for other future purposes, such as to prepare the objects for exhibition or loan.

Condition of the cauldrons

The visual appearance of the cauldrons remained largely unchanged from the time of their excavation but the condition of the metal had deteriorated over the protracted two-year acquisition period. There appeared to be an increased level of mineralisation to the metal sheet causing brittleness and susceptibility to breakage.

The copper alloy, typically a fraction of a millimetre thick, retained only isolated areas of metal but had a discernible original surface underlying the soil deposits with a thin layer of corrosion products including carbonates (probably malachite and azurite) and oxides (probably cuprite and tenorite). In places the mineralisation was extensive and abscesses of copper chlorides with no strength or structure extended through the thickness of the metal sheet (**Fig. 21**).

The iron sections of the cauldrons were highly corroded and mineralised throughout with 5–10mm of orange iron oxide corrosion products penetrating the surrounding soil above the compact grey magnetite layer. Some areas of iron rim and handle had ‘exploded’ with deep splits penetrating through the iron corrosion and into the core. The most deteriorated example of iron, from band A of cauldron 14, had corroded to such an extent that it consisted of a soft corrosion product which was hard to distinguish in texture from the overlying mineralised organic remains. However, many cauldrons retained a layer which approximated to the ‘original’ surface of the metal and where any remains of decoration could be found.

The physical condition of the objects varied greatly depending on their orientation and position in the pit. Cauldrons deposited upright, and therefore filled with soil during the backfilling of the pit, or those protected by their



Figure 22 Mineralised organic remains preserved extensively in contact with the iron rim and band A of cauldron 9

placement within other cauldrons, had largely retained their three-dimensional shape. However, the cauldrons placed upside down, which were hollow when buried, were highly distorted and in many cases the copper alloy base section of the cauldron had detached from, and been pushed into, the iron rim by the weight of the overlying soil.

During micro-excavation it became apparent that the physical condition of the cauldrons in the undisturbed soil blocks was highly fragmentary and more fragile than anticipated. While the cauldrons appeared largely whole, the metal was riven with hairline cracks and was, in effect, a series of hundreds of tiny fragments held in position by the soil.

The condition of the cauldrons had been further affected by the initial excavations and the on-site lifting of the cauldrons. The excavation by the metal detector user resulted in the disruption of several of the cauldrons and the undocumented removal of sections of copper alloy and iron

Figure 23 Food residues on the interior surface of a copper alloy fragment from cauldron 11



rim which could not later be reassigned to particular objects. It is estimated that six or more cauldrons were affected in this way with significant loss of information. The lifting methods employed to remove the cauldrons from the site led to further disruption of the objects. Establishing the deposition and number of cauldrons was much more complex than initially hoped, with stacked and overlapping cauldrons as well as individually deposited sections or fragments of vessel. The full extent of the deposit was not apparent until laboratory excavation and imaging of the block lifts had occurred. Lifting the cauldrons in adjacent blocks made reconstructing individual cauldrons and their location within the deposit more challenging.

Mineralised organic remains were extensively preserved in contact with the iron and within the surrounding soil (**Fig. 22**) (see Chapter 10). The presence of mineralised remains caused a dilemma as their extensive preservation obscured the surface of the objects. It was decided that, as the organic remains were not integral to the construction of the cauldrons, those in the soil away from the metal surface would be removed after recording their location, with better-preserved samples kept for identification. Those directly in contact with the surface of the object were kept in situ unless covering important detail such as decoration, patching or joins in the iron.

Residues were present on both the interior and exterior of the copper alloy. The exterior deposits on the base of the cauldron formed a very thin black and finely particulate layer on the surface of the copper alloy – possibly sooty residues from the fire over which they were hung. Thick black food residues (up to 10mm in places) were present on the interior of the cauldrons, between joins in the sheet metal and on the exterior of the rim and iron band. The residues were sampled for identification (results of the analysis can be found in Chapter 9), and were preserved on the surface of



Figure 24 Conservator Alexandra Baldwin micro-excavating cauldron 9 in the conservation studio

the copper alloy and iron unless they obscured technological detail (**Fig. 23**).

Micro-excavation

After the cauldron blocks were transported to the laboratory for conservation the first stage was to reveal the contents of the blocks by micro-excavation (**Fig. 24**). The plaster bandages and cling film were cut away incrementally in narrow strips to reveal the soil within, but enough of the support was retained to maintain the stability of the block. The Japanese tissue and Vinamul 3252 (ethylene vinyl acetate co-polymer) facings applied on site were removed by injecting water between the metal surface and the tissue with a syringe. This caused the adhesive to swell enough to gently peel the facings back from the surface using tweezers. The soil was excavated with small hand tools such as leaf spatulas, scalpels and dental tools. The clay and chalk fill of the blocks was extremely hard and the soil required softening with IMS (industrial methylated spirits) and deionised water. As the soil was removed, and the fragments of vessel within the soil revealed, they were either immediately rejoined in situ, or if a join could not be established, removed after recording their position with detailed photography or drawn plans. The exposed surface of the metal was cleaned with a scalpel and swabbed with IMS and deionised water while still supported by the underlying soil. Consolidation of highly mineralised areas of metal was carried out using a 3–10% weight/volume solution of Paraloid B72 (ethyl methacrylate co-polymer) in acetone depending on the nature of the corrosion or cracks to the metal surface. The soil from within the cauldrons, as a sealed and uncontaminated context, was kept for further analysis.

Owing to the highly fragmentary nature of the cauldrons within the blocks, and the thinness and distortion of the metal, it proved impossible to excavate the soil from around the cauldrons while supporting their three-dimensional structure. Instead the metal was revealed, carefully documented and recorded, and then lifted out of the block in

large sections to be reconstructed later. The sections of thin sheet copper alloy required facing during removal from the block to prevent further fragmentation.

The uneven surface of the corroded metal meant that the sheet facing material used needed to be flexible. Additionally, owing to the consolidation and initial joining of the metal, any adhesive used to adhere the facing needed to be easily removed from the surface of the metal without weakening the repairs already undertaken. For these reasons Japanese paper and a solution of Klucel G (Cellulose Ether) 40–50% w/v in IMS were chosen for the temporary facing of the metal sheet. The IMS within the Klucel G reduced the curing time of the adhesive, and using it at a high gel-like concentration increased the strength of the facings and the quality of adhesion to the substrate. The long fibres of the Japanese tissue had the required strength to support the metal and it was flexible enough, especially when wetted, to conform well to the corroded surface. A medium-weight Kozo or Usu-mino paper was chosen owing to its long fibre length, thickness and strength when wet. Klucel G, which is soluble in both IMS and cold water (Horie 1987), could be easily softened for the removal of the facings without affecting pre-existing repairs in HMG cellulose nitrate and Paraloid B72 (**Fig. 25**).

Cleaning decoration on the iron handle plates

All the fragments of iron were cleaned mechanically under $\times 30$ magnification to remove soil and corrosion using pliers, scalpels and small hand tools. The iron was then lightly air-abraded with aluminium oxide powder to remove remaining overlying soil residues.

Decoration on the surface of the iron bands was only detected through careful examination of the sheet and the cross section of break edges around the handles. Further detailed cleaning of decorated areas down to the 'original surface' had to be carried out to clarify details of the decoration and construction. Cleaning to this level on thin corroded iron increased the risk of breakage, especially of



Figure 25 Facings of Kozo paper and Klucel G applied to the surface of cauldron 9 to prevent disintegration of the copper alloy sheet during undercutting and removal from the soil block



Figure 26 Detail of decoration on the iron handle plate of cauldron 6 before and after cleaning

the repoussé decorated sheets which had a void beneath. It was also time-consuming and required the removal of overlying mineralised remains and residues, and therefore led to a potential loss of information. However, it was felt that, owing to the failure of X-radiography to reveal the decoration and the rarity of decoration on this class of object, further cleaning was required. The corrosion overlying the decoration was, in many places, very hard and shiny. Underneath this corrosion layer the detail of the decoration was obscured by a thick layer of food residue. The metal was softer than the overlying corrosion and the decorated surface often indistinct and hard to find within the corrosion layers (**Fig. 26**).

Very fragile and thin areas of iron which required this higher level of cleaning were supported on a backing of Japanese tissue adhered with a 30% solution of Klucel G in IMS. In other instances, the reverse of the fragments was cast in plaster of Paris with a cling film separating layer to form a rigid support, enabling detailed mechanical cleaning to be carried out without damage to the iron bands. Cleaning was carried out manually using scalpels and small hand tools with additional removal of very hard corrosion with a Dremel variable speed mini drill and a high-speed cutter with a spherical head.

The identification of details of construction, tool marks and decoration both on the copper alloy and the iron depends on the level of cleaning – while the purpose of conservation was to reveal information for publication, the same levels of cleaning could not be applied to all areas or all cauldrons due to limitations of time and resources.

Reconstruction

Reconstruction of the vessels to a certain level was required to enable a study of their technology and manufacture. In many cases the level of reconstruction was fairly extensive due to the highly corroded and fragmented condition of the vessels. **Figure 27a–b** illustrates the condition of the rim and handle of cauldron 14 on removal from the soil block and after reconstruction and cleaning.

Choice of adhesive

When choosing an adhesive for repair it is usual to select one that is weaker than the substrate so that if the object is placed under stress the joint will fail rather than causing a fresh break to occur to the object. However, the thinness of the copper alloy sheet and the consequently very small surface area of the break edges meant that suitable adhesives such as HMG cellulose nitrate or Paraloid B72 could not support the weight of the metal. Leaving the cauldrons in small fragments was not appropriate as this would reduce the legibility of the objects and the fragments would be at risk of loss or displacement causing a loss of information.

Stronger adhesives such as epoxy, polyester resins and Cyano-acrylates have been routinely used for the reconstruction of thin sheet metal vessels in the past (Niemeyer 1997; Balboa *et al.* 2013). In the case of the Chiseldon cauldrons, with the high level of mineralisation of the metal sheet, it was decided that a stronger adhesive would be inappropriate as failure of the metal substrate adjacent to the join was likely. Instead a weaker adhesive with additional support backing of the joins was decided

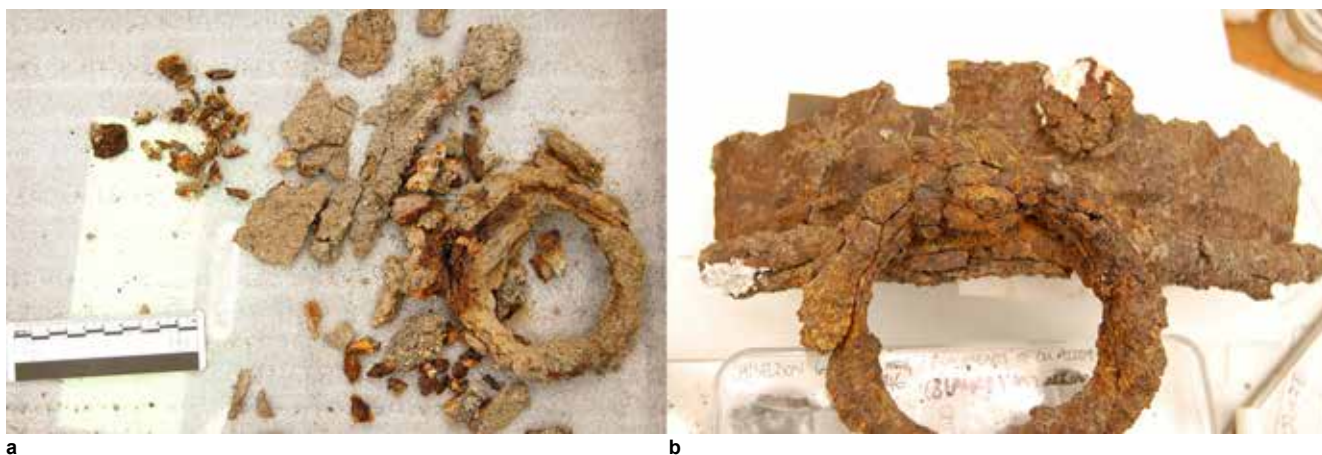


Figure 27a–b Highly fragmented iron of the rim, band A and handle of cauldron 14 before and after reconstruction

upon. Both Paraloid B72 and HMG cellulose nitrate adhesive have been used frequently in the conservation of metal artefacts and the choice for their use in a particular object treatment is largely governed by the differences in their working properties (Lane 1974; Koob 1982; Niemeyer 1997). Concerns about the long-term stability of cellulose nitrate adhesive have been raised, in particular degradation due to light exposure causing discoloration, brittleness and deterioration (Koob 1982; Horie 1987). However, it has many advantages over the use of Paraloid B72, and in particular with the extreme difficulties of immobilising the thin, fragile and distorted copper alloy during joining, the higher level of tack and quicker curing time of HMG cellulose nitrate made it a relevant choice.

Removable supports

Where practical, a removable support was made to back large areas of sheet copper alloy. While its removability ensured that the interior surface could be studied and recorded, casting directly onto the metal to mould the interior form proved difficult as the metal could not withstand any amount of pressure applied to it. Where the underlying soil retained the shape of the fragments the soil was cast to provide a support instead of the metal. For more complex shapes the metal fragments were supported externally while sheets of dental wax, which could easily be manipulated with a hot air blower to sink onto the metal sheet with minimum pressure, were used to create a former. Supports were then cast from these formers in either glass fibre or silk crepe line, and polyester resin or Araldite 2020 epoxy resin (**Fig. 28a–c**). Polyester resin has a long history

of use in the backing or support of metal vessels in combination with glass fibre (Lane 1974). However, it has less cured strength and hardness than epoxy and a thicker layer is needed. Additionally, polyester resins shrink by 8% during curing and emit styrene for some time after curing (Davison 1998), unlike epoxy resins where the shrinkage factor is minimal at 0.68% for Araldite 2020 (Shashoua and Ling 1998). Araldite 2020 was chosen over other epoxy resins because of its relatively shorter curing time of 12 hours to surface dry and three days to harden completely (Shashoua and Ling 1998).

Further support systems to areas of folded metal, where backing or removable supports could not support the weight of the joins to the metal, were trialled. Props made from thin Perspex rods (clear acrylic) were inserted into cups cast in Araldite 2020, which were in turn attached to backing or directly to the metal surface with Paraloid B72 (**Fig. 29**).

The removable supports described above were practical for some cauldrons; however, they were very time-consuming to make, required extensive handling of the metal (putting it at risk of further damage), and were not ideal for many of the cauldrons. Additionally, as the supports were removable many of the joins still required direct backing, as described below.

Choice of backing

Owing to the extreme fragility of the copper alloy and the weight of the iron rims and handles, a full reconstruction of any of the vessels would require direct backing of the entire interior surface of the cauldron. This has been the preferred treatment in the past for fragile archaeological metal vessels,

Figure 28a–c The construction of a support for the copper alloy base of cauldron 4: a) modelling the interior surface of the copper alloy with dental wax; b) polyester resin and fibre glass cast onto the dental wax former; c) completed support





Figure 29 Perspex rods and sockets cast in Araldite 2020 used to support a folded area of copper alloy sheet of cauldron fragment 21

and many silver or copper alloy thin-walled vessels which were required for display have either total or partial backing. Lane (1974) documents the use of polyester resins and fibreglass for the filling and backing of missing areas of thin-walled metal vessels, a combination which was commonly used at the British Museum from the 1970 to the 1990s, and has been used more recently to back sections of a copper alloy cauldron from Barcelona, Spain (Balboa *et al.* 2013). Other materials used in combination for backing thin sheet metal include epoxy resin and polyester fabric, cellulose nitrate and glass fibre (Neimeyer 1997) and Hxtal NYL-1 epoxy resin and glass fibre (Balboa 2013 *et al.*).

In the case of the Chiseldon cauldrons, the surface of the metal retained many interesting construction features and residues and, as the main purpose of conservation was to extract information for publication, it was felt that a full backing and reconstruction would be inappropriate as it would cover evidence and put the physical stability of the object at risk. Instead the vessel fragments were reconstructed into smaller sections of cauldron which were easier to handle, but which remained readable and easily identifiable, and could be made physically stable with a minimum backing of the joins.

Several different combinations of adhesive and a sheet material were trialled. The requirements for the backing included: transparency; strength enough to support the join; a flexibility of the sheet material so that it could conform well to the uneven surface of the metal and support the join; and a degree of reversibility of the backing adhesive.

HMG cellulose nitrate adhesive and nylon gossamer (synthetic polyamide tissue) were trialled as small tabs (approx. 5 × 10mm) across joins. This combination of materials has been used regularly in the past on other metal objects with the advantage that the nylon gossamer is flexible and the tabs can be almost invisible if applied correctly. However, cellulose nitrate adhesive in a typical formulation is made up of at least 75% solvent (Koob 1982; Horie 1987) and shrinks on curing (Davison 2010). With the slightly dusty surface of the cauldrons the shrinkage caused the backing to pull away from the surface and curl up leading to the failure of the join. When used in larger sheets the contraction of the adhesive had the strength to potentially cause curling of the metal. The shrinkage could be mitigated slightly by slowing the evaporation rate of the

solvent by covering with aluminium foil after application, but generally it was too unpredictable for use as a backing.

Paraloid B72 and nylon gossamer in combination do not work well as bubbles form under the nylon gossamer during evaporation of the solvent pushing the backing material off the surface of the metal. This causes a weakening of the join as the backing material is not well adhered to the substrate and it is aesthetically unappealing. Additionally, while nylon gossamer is acceptable for smaller tabs it would be unsuitable over large areas as it is translucent.

Paraloid B72 and silk crepe line in combination as a backing material provided a good substitute for nylon gossamer and cellulose nitrate tabs. Silk crepe line has the advantage that it is a fine, flexible sheet material with a high tensile strength and has a higher transparency than nylon gossamer. Application of the silk crepe line backing to the surface of the metal could be achieved by dipping the crepe line in a 30% w/v solution of Paraloid B72 in 50/50 IMS acetone and applying the tab straight to the surface. However, this method had to be carried out quickly due to the rate of evaporation of the solvent and it could be quite difficult to get the right amount of adhesive onto the crepe line in the short working time. Too much adhesive made the Paraloid prone to bubbling, while too little meant that the crepe line did not adhere well to the metal surface.

The preferred method was to impregnate the silk crepe line with Paraloid B72, allowing it to cure. It could then be reactivated when required by dipping it in acetone for a few seconds. Any shrinkage that occurs to Paraloid B72 during the setting process (although significantly less than that of HMG cellulose nitrate) is mitigated by pre-casting and reactivating the cured sheet (Koob *et al.* 2011). This application method had the advantage that it was less messy, and the amount of adhesive could be controlled by casting the sheet of Paraloid in different thicknesses. The impregnated sheet also could be easily cut down to the required size. The method for casting the Paraloid as a sheet was similar to that outlined by Koob *et al.* (2011). A 30% w/v solution of Paraloid B72 in 50/50 acetone and IMS was poured onto a sheet of Melinex (archival quality clear polyester film) and tilted to spread the resin to the required thickness. A sheet of silk crepe line was then laid over the top and gently pushed into the resin puddle. To reduce the rate of solvent evaporation, and therefore the formation of



Figure 30 The copper alloy section of cauldron 14 reconstructed with small areas of loss backed with silk crepeline and Paraloid and a larger support of silk crepeline and Araldite 2020

bubbles, the sheet was covered with a large glass container and placed in the fume cupboard to off-gas.

Paraloid B72 and silk crepeline worked well as small tabs and strips to support joins and could additionally be used to bridge areas of loss or weakness (**Fig. 30**). However, the silk crepeline also had limitations as it only bends in one direction and is therefore unsuitable for backing complex curves and, in combination with Paraloid, is relatively weak and proved unsuitable for areas where the copper alloy was highly fragmented, incomplete or where the stress and tension on the backing material was greater. For these areas there was no choice but to use a stronger backing material and adhesive.

Epoxy resin has the advantage that it is a strong rigid resin and when cast as a layer or used with an additional sheet material the support can be relatively thin in comparison to other resins such as polyesters. Araldite 2020 is a versatile epoxy that has been used as a cast sheet material for backing glass (Davison 1998; 2003; Koob 2006; Barton *et al.* 2013). Cast sheets of Araldite were experimented with, but even when manipulated while still setting or heated to make flexible (Davison 1998; Barton *et al.* 2013) its tendency to revert to a flat state put pressure on the fragile metal.

Instead, where there was no other practical alternative, nylon netting and Araldite 2020 was applied directly to the interior of the object. This had the advantage that large areas of highly fragmented or complexly curving sheet copper alloy could be partially backed. The nylon netting

has strength, and due to its open structure conforms well to complex curves and is transparent. Its use with the Araldite 2020 gave it rigidity and enabled the joining of sections of the cauldrons that would have otherwise remained in unreadable loose fragments.

Araldite 2020 was difficult to work with in this way as the setting time required the immobilisation of the fragments during curing. As a freshly mixed adhesive it is quite runny and has low levels of tack so it was used semi-cured, but the exact point of optimum working was hard to predict as the setting time varied depending on the ambient temperature. This left only a small working window before the adhesive became too viscous to apply. The method of application was to dip the netting into a shallow puddle of Araldite to fill the cells in the netting and then apply it to the interior of the copper alloy, being careful to avoid areas of technological interest. The netting could then be pressed onto the surface using a natural bristle brush with a little more Araldite (**Fig. 31a–c**).

A drawback to the use of Araldite in direct contact with the metal surface is its reversibility; however, the application of dichloromethane in a gel should be sufficient to swell the adhesive enough for the backing to be peeled off and the adhesive removed from the surface (Horie 1987; Davison 1998; Shashoua and Ling 1998).

Support fills

Reconstruction of the fragments enabled the majority of the cauldrons to be reassembled into large sections which could

Figure 31a–c The process of applying Araldite 2020 and nylon netting support to the copper alloy bowl section of a cauldron: a) applying Araldite to the netting; b) netting with some cells filled with Araldite; c) applying the netting to the object

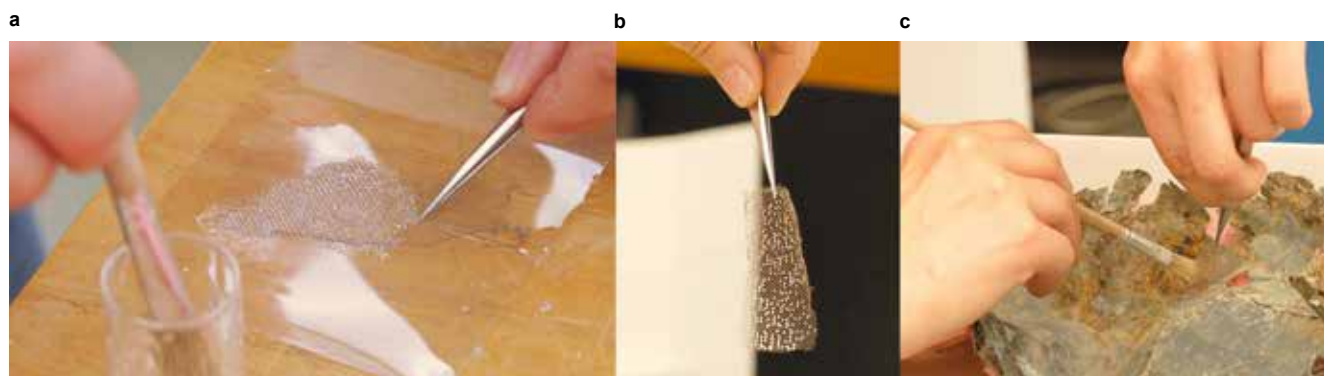




Figure 32 Cauldron 10 packed in a Correx box with Plastazote supports

be placed together to suggest the form and shape of the vessels. Generally, the copper alloy bowl and band were reconstructed into three or four main sections. Fills were limited to those required to support joins or the shape of the vessel without which the physical stability of the object would be compromised. As already described, gaps within the copper alloy were backed with either silk crepeline and Paraloid B72 or Araldite 2020 and nylon netting. Further fills or tinting-in were deemed inappropriate for study and storage of the vessel but could be done in the future if required. The iron rim and bands of the cauldrons, which were often more sturdy owing to the thicker metal and greater rigidity, could have been fully reconstructed for many of the objects, but the large size of the vessels would have made them unwieldy and difficult to handle, study and document so they were joined into smaller sections. Where support fills were required to reconstruct the sections of the iron bands and rim they were carried out with a 50% w/v solution of Paraloid B72 in acetone and micro-balloons.

Storage

As both the copper alloy and iron appeared relatively stable with no active corrosion and the objects are stored in a dry store with a relative humidity (RH) of between 40–50%, no chemical stabilisation of the metal was carried out. Where possible, larger fragments of cauldrons were packed together and sections which join were placed adjacently so that the form of the cauldrons could be more easily identified. In many cases, due to the weight of the iron rims and the fragility of the copper alloy, it was decided that the copper alloy and iron sections should be packed separately to ensure the physical stability of the objects, but clear orientations of the sections were marked in the packaging

and the exact position of the joins were marked on the metal with white acrylic ink >I<. The packing of the cauldrons proved challenging as the complex shapes of the three-dimensional fragments presented individual packing issues. Additionally, because of the fragility of the metal, especially the copper alloy base sections, the edges were prone to crumble or snag and for these reasons packaging that surrounds the fragments, such as acid-free tissue paper, was deemed inappropriate. It was also felt that, to reduce the need for unpacking and repacking the cauldrons, a system which allowed easy viewing and therefore minimum handling of the fragments and packaging was desirable.

To store these outsized sections of base and rim large boxes and lids were made from Correx (thin-walled corrugated polypropylene) and secured with nylon cable ties. An internal tray of Correx with a 25mm sheet of Plastazote was used as a base on which to pack the cauldrons so that they could be removed from the box without being touched. Where packed upright the copper alloy base sections were supported externally with a series of triangular wedges cut from 25mm Plastazote sheet. The shape of the external profile was measured with a profile gauge so that the wedges could be cut to an exact shape and give maximum support to the cauldrons. The wedges were held in place with bamboo skewers which penetrated through the wedges and into the Plastazote and Correx base board. Cauldrons with the copper alloy still joined to the iron of the rim were packed upside down. The rim was held in place with curved strips of Plastazote, both internally and externally, and the copper alloy base supported on the interior with wedges of 25mm Plastazote cut to the internal profile as described previously (**Fig. 32**).

Fragments of copper alloy and iron associated with the cauldrons, but for which no join could be found, were repacked after conservation and grouped by object or context. Smaller fragments were placed in Crystal boxes (clear polystyrene boxes) or finds bags lined with Plastazote or Jiffy foam (closed cell polyethylene foam). Larger fragments were packed in Stewart catering boxes (polypropylene) lined with Plastazote and held in position with Plastazote wedges and supports. All boxes and bags were labelled externally with the site code, context number, small find number and Museum registration number.

Documentation

X-radiography

X-radiography is usually carried out on archaeological material prior to conservation to reveal details of construction and the condition and location of the objects or fragments within soil. However, the X-radiography of un-cleaned fragments carried out during the assessment stage of this project proved unrevealing due to the thin and highly mineralised nature of the metal and the relative density of the surrounding soil. X-radiography of the cauldrons lifted in blocks was not attempted as the blocks of soil were too large and dense and would not reveal meaningful data. CT scanning of two of the soil blocks was carried out and is discussed in Chapter 5. X-radiography was also done after the cleaning of decorated or patched fragments of iron in an attempt to reveal hidden details of construction such as rivets. The X-radiography was carried out using a TORREX TRX 5200 radiation-shielded system operating at a standard 3 mA with exposure levels of 100–30 Kv for 1–10 minutes depending on the condition, thickness and type of metal. Agfa D4 film was used for the image

capture with a lead backing sheet to reduce backscatter. The X-ray films were then scanned using an Agfa RadView digitiser with a 50 µm pixel size and 12-bit resolution and the images digitally manipulated and enhanced with Adobe Photoshop 11. This revealed limited additional information to that visible on the surface of the object after cleaning. Again this was due to the highly mineralised state of the iron and the very thin decorative repoussé sheets. Selective X-radiography of the copper alloy proved more helpful and revealed marking out lines and other hidden details of manufacture.

Visual documentation

Photography was carried out before, during and after conservation to provide a full record of the process. Accurate detailed drawings using a planning frame were undertaken for the first cauldron micro-excavated to provide a record of fragment locations within the block as the level of the soil was reduced. This proved very time-consuming, and for subsequent blocks was replaced by annotated photographs and tracings on Melinex as the block was taken down in layers. These working images were later digitised to provide a permanent record of the micro-excavation. Detailed notes were taken during the excavation of the blocks and during conservation to provide the basis of conservation records and the publication. Full object descriptions and details of conservation were recorded on the Museum's database and images and drawings of the objects stored on the digital image database and linked to the individual object records. Photogrammetry and laser scanning of the blocks during excavation and fragments after removal and conservation were carried out by Stephen Crummy for digital illustration and reconstruction.

Chapter 5

CT Scanning of Two Soil Blocks

Jody Joy, Mark Mavrogordato and Alexandra Baldwin

Introduction

Jody Joy

Early in the process of conserving, excavating and researching the cauldrons, it became apparent that it would not be possible to excavate fully all of the soil blocks in the time available, owing to the increased total number of cauldrons and the complexity of their condition. Rather than further delay publication, it was decided to scan the two remaining blocks containing cauldrons 5 and 6, and cauldron 8, using a micro-focus X-ray Computed Tomography (X-CT) scanner. Our aim was to establish how many cauldrons each block contained, to record basic dimensions and, if possible, to identify aspects of technology such as the methods of rim construction and handle attachment. It was hoped that this would provide sufficient information to produce a meaningful publication without putting the objects at risk by rushing excavation and conservation to meet project timescales. Additional funding and time to excavate the remaining cauldrons from their soil blocks will be sought in the future. The information derived from the X-CT scans will help also to facilitate and speed up the excavation process by providing an understanding of the number and arrangement of cauldrons in each block.

In 2012 the author was made aware of a University of Southampton-funded scheme to promote the use for research of the University's μ -VIS X-ray Imaging Centre and their large high-energy micro-focus X-CT system. The British Museum had recently collaborated very successfully with μ -VIS to scan the Selby Roman coin hoard, two small ceramic beakers *c.* 10cm in height and diameter filled with corroded silver coins, soil and organic matter, so we were well aware of the potentially excellent results that could be achieved. In the case of the coins, the exceptionally high-energy/high-resolution combination of the Southampton facilities produced detailed scans allowing the coins to be examined before physical excavation or cleaning (http://www.southampton.ac.uk/mediacentre/news/2012/jul/12_106.shtml). 3D computer visualisation capabilities made it possible to read inscriptions and identify depictions of emperors on the faces of the coins from the scan data.

The scanning of the block containing cauldron 8 was undertaken during December 2012 and this collaboration resulted in a short BBC film which was first broadcast via the BBC News website on 31 January 2013 (<http://www.bbc.co.uk/news/technology-21235980?SThisFB>). We are very grateful to Dr Fraser Sturt and Professor Graeme Earl, as well as Dr Mark Mavrogordato at μ -VIS, for arranging the scanning of this soil block. Funded by the project grant from the Leverhulme Trust, block 5/6 was later scanned in July 2013.

Scanning methods

Mark Mavrogordato

The University of Southampton's μ -VIS X-ray imaging centre is a dedicated centre for computed tomography (CT) at Southampton, providing complete support for 3D imaging science, with applications in the fields of Engineering, Biomedical, Environmental and Archaeological Sciences. The centre has five complementary scanning systems supporting a wide range of sample sizes (imaged volumes up to $1.5 \times 1 \times 1$ m) and resolutions (down to ~ 200 nm).



Figure 33 Nikon/Metris custom-designed dual source micro-focus CT system housed within the University of Southampton's μ -VIS X-ray Imaging Centre

Among other systems, the μ -VIS CT imaging centre houses what is currently one of the largest high-energy micro-focus CT systems in Europe, originally designed for the analysis of substantial engineering parts, such as jet turbine blades. This is a Nikon/Metris custom-designed dual source micro-focus CT system, and was used for this investigation (**Fig. 33**).

The system was configured to use a Nikon/Metris 450kV micro-focus source in conjunction with a PerkinElmer 1621 XRD type detector. Owing to the large size of the cauldron blocks ($\sim\varnothing 60\text{cm}$), it was necessary to increase the effective detector width using a panel shift scanning approach.

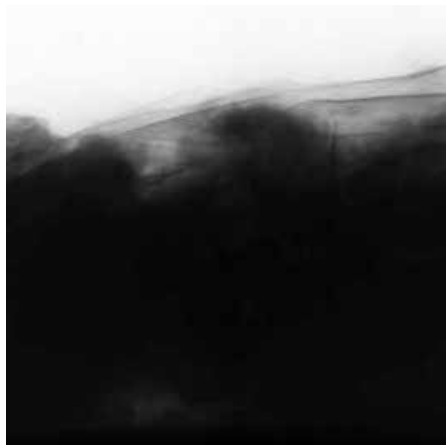


Figure 34 (left) Radiographic image showing single panel radiograph. Here the width of the specimen is greater than the field of view of the detector

Figure 35 (below) Radiographic image acquired using a 4-position panel shift. Here the entire width of the specimen is well within the field of view



Tube voltage	380kV
Current	400 μ A
Filtration	16mm Cu
Number of angular projections	5614
Frames per projection	1
Voxel size	0.308mm
Exposure	1 second
Detector binning	2x
Total scan time	$\sim 30\text{hrs}$

Table 1 Scan parameters

During a panel shift scan the detector is moved horizontally into up to four positions, enabling the effective width of the detector to increase from $\sim 40\text{cm}$ to $\sim 150\text{cm}$ (**Figs 34–5**). The scan parameters can be seen in **Table 1**.

The cauldron block was rotated 360 degrees and 2D images were taken at each rotational step to capture the data in different orientations during a scan time of approximately 30 hours per block. The scan was reconstructed using CTPro and CT Agent version XT 2.2 software (Nikon Metrology) and the images were then visualised and processed using VG Studio Max 2.1.4 (Volume Graphics GmbH) to build detailed 3D images (**Fig. 36**).

While the flat panel scans enabled the entire specimen to be scanned as a single volume, the size and density of the block presented challenges from a CT imaging perspective. The peripheral regions of the block, which included the cauldron itself, are clearly visible; however, within the practical constraints of the investigation, the central section of the block lacked a certain amount of fidelity due to photon starvation and other CT imaging artefacts.

A further – local – scan was conducted using the 450kV source combined with the collimated Curved Linear Diode Array (CLDA). The use of the CLDA greatly reduces the effects of X-ray scatter. The CLDA was used to scan a small region around one of the cauldron handles, and was able to indicate the manufacturing methods and type of fastening mechanism used in this particular specimen (**Fig. 37**).

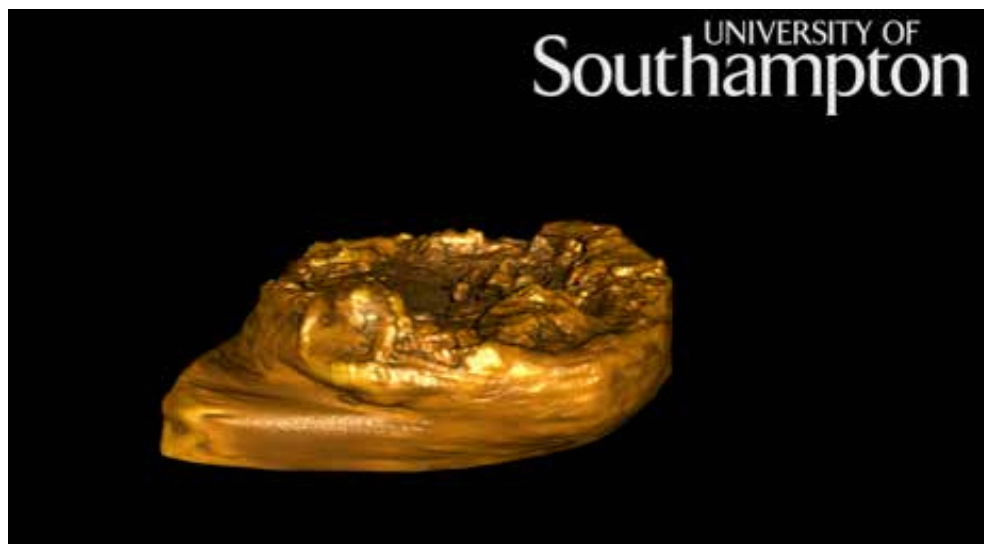


Figure 36 Image showing 3D reconstructed rendering using VG Studio Max 2.1.4 (Volume Graphics GmbH)



Figure 37 Image showing reconstructed handle taken from scan using the Curved Linear Diode Array (CLDA) type detector

Results

Alexandra Baldwin and Jody Joy

Block 8

The use of CT scanning over traditional X-radiography presented many advantages – not least the ability to image such a large block which, owing to the relative density and volume of the soil and the lack of density of the highly corroded and relatively thin metal, would not have been otherwise possible. Even using the state-of-the-art CT scanning facilities at the μ -VIS centre, owing to the density of the soil and the large block size, it was not possible to process the data fully and the block had to be viewed in slices, which are harder to interpret. Additionally, the thinness of the sheet copper alloy and its crushed condition meant that the layers of copper alloy visible in the scan were difficult to read. Depending on the position of the particular slice viewed a single but fractured sheet of copper alloy may

appear to be several sheets due to displacement and overlapping.

Nevertheless, it was possible to tell that the block contains the remains of a single near-complete cauldron positioned the right way up in the deposit and sitting over a large stone which has pushed the side and base of the cauldron inwards (**Fig. 38**). In addition to cauldron 8 it is possible that there may be further sheets of copper alloy deposited intentionally as fragments within cauldron 8 at the centre of the block, although this may also be displaced metal from the base of the cauldron. The rim and iron bands as well as the cauldron type were clearly discernible and measurements of the gross aspects were taken. Finer detail such as rivet size and distribution, and any patching, while present in the data would take further time and processing to reveal.

With the software used (ImageJ) to view the scan data it was possible to take measurements of various features within the blocks, but the accuracy of these measurements



Figure 38 Image of block containing cauldron 8 (stone is in the bottom left)

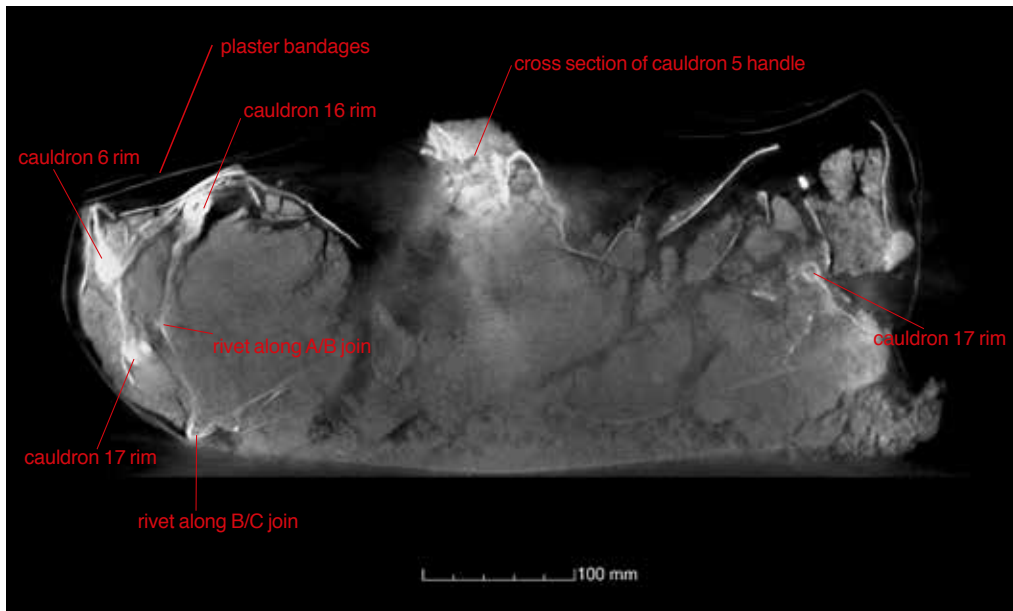


Figure 39 Image slice of cauldron block 5/6 in north-south section

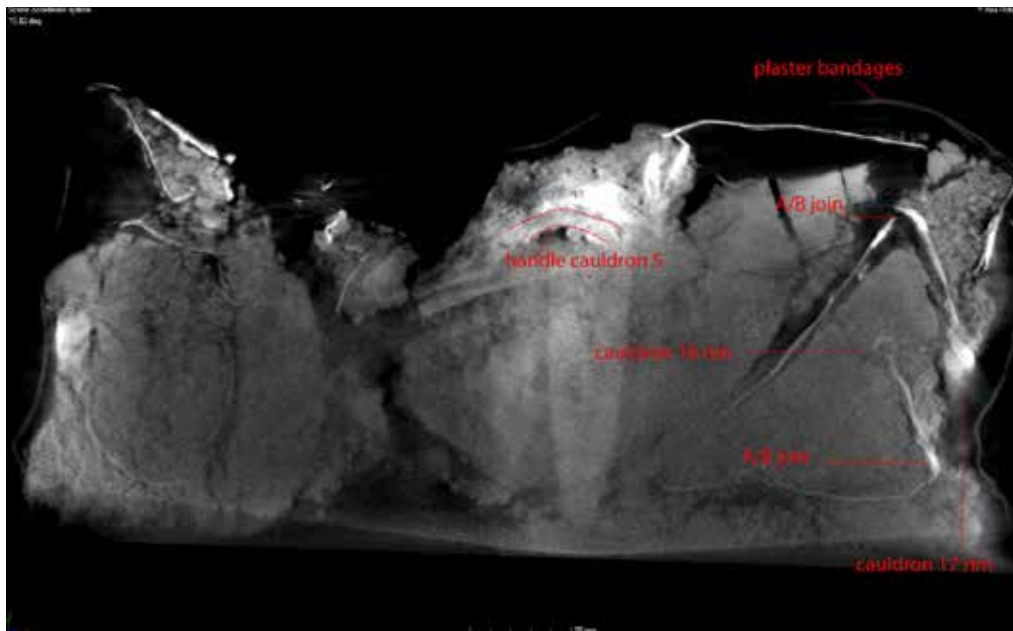


Figure 40 Image slice of cauldron block 5/6 in east-west section

depended on the angle of the slice through the feature. For example, if the cross section of the rim was measured on a slice that was at a slightly oblique angle through the rim, the measurement would be greater than in reality. Therefore, the measurements taken from the scan data need to be viewed with some caution and are a guide only.

The cauldron is 520mm in diameter and an estimated 350mm in depth. This makes it one of the larger cauldrons in the group. Like several others excavated from the site, it has a hollow type 1 rim and iron band with a dogleg below the rim, and a tri-ribbed handle attachment. The copper alloy section is made in two parts with a copper alloy band B and bowl C joined with rivets. The ring handles are 130mm in diameter, making them the largest handles from any cauldron at Chiseldon.

An additional feature of CT scanning and 3D visualisation is the ability to adjust grey-level threshold values and then virtually 'strip back' the corrosion to reveal layers of detail within the corrosion and within the object

itself which may not be possible when cleaning the object during conservation (see **Fig. 38**). In this way the original surface of the handle of cauldron 8 was revealed virtually, allowing its dimensions and probable overlap within the metal to be distinguished.

Cauldron block 5/6

In comparison to block 8 the contents of block 5/6 are far more complicated. Like the previous scan, the density of the soil proved very difficult to penetrate, and again the processing time required for such a large block meant that the results of the scan were viewed in slices making it difficult to interpret the complex deposit. Unlike the block containing cauldron 8 this block contains more than one cauldron, with the complete or partial remains of at least four cauldrons visible on the scan (**Figs 39-40**). The condition and number of the cauldrons make the scan difficult to interpret. For a start none of them are cauldron shaped, but crushed and distorted, which makes them

harder to distinguish, and on one side of the block a series of fragments of iron rim and band broken away from the body of the cauldrons within the soil matrix are hard to identify and assign to any one cauldron. As far as can be interpreted from the scans, and inference from the orientation and positioning of the cauldrons in the ground, block 5/6 appears to contain the east handle of cauldron 5 in the centre of the block as well as remaining rim fragments from cauldron 6 to the north and south side of the block and the majority of the copper alloy base section. In addition to the remains of these two cauldrons, fragments of which were lifted from the top of the block during excavation, there appear to be two further previously unknown cauldrons 16 and 17. From details of the scans it can be seen that cauldron 16 sits at the bottom of the block and has been deposited the right way up with cauldron 17 inverted over the top.

Cauldron 16 is approximately 332–40mm in diameter and 260mm deep. The rim appears to be a hollow type 1 rim with circular cross section 18 × 11mm. Band A is approximately 80mm wide with a dogleg below the rim. The handles of cauldron 16 are not visible. Copper alloy band B is approximately 157mm wide with the bowl of the cauldron approximately 177mm in diameter and 16mm deep. The rows of rivets along the A/B and B/C overlaps were clearly visible especially when travelling through the slices as they are denser than the copper alloy either side.

Cauldron 17 sits inverted over cauldron 16 and is 505mm in diameter. Although the profile of cauldron 17 is harder to discern in the scan results, possibly due to a greater level of mineralisation of the metal, and the banding is more fragmentary, it too appears to be a cauldron with a hollow rim type 1 (with circular cross section 18 × 18mm) and a dogleg in band A below the rim. One of the handles of cauldron 17 was visible in the scan data at the edge of the block, but was difficult to distinguish, again possibly due to a high level of mineralisation.

Evaluation

Jody Joy

Scanning of the Chiseldon soil blocks demonstrated the benefit of CT scanning of this type to archaeological research, even when the condition of the sample (very thin metal and very dense soil) is far from ideal for the scanning process. The results derived from the Chiseldon scans may not be as glitzy as those from the Selby Roman coin hoard, but nevertheless it was possible to identify and measure objects from the scans, as well as to distinguish diagnostic features. The scans will also prove invaluable when we are eventually able to excavate the two soil blocks.

Chapter 6

Technology, Manufacture and Decoration

Alexandra Baldwin, Jamie Hood
and Jody Joy

Perhaps the most significant area for study presented by the discovery of the Chiseldon cauldrons is the possibility to examine the techniques and methods of their manufacture. With 17 cauldrons originating from one context, the find offers a unique opportunity to study roughly contemporaneous and geographically local objects.

Variation in the Chiseldon group is evident in many features, from the size and proportion of each vessel, to the shape and distribution of the rivets. Detailed examination and comparison of the manufacturing techniques is therefore crucial in establishing whether differences and similarities relate to factors such as workshop and regional variation, or development and refinement of construction over time.

Cauldron types

Alexandra Baldwin and Jamie Hood

All cauldrons from Chiseldon fall into Group II of Joy's typology (Joy 2014) (**Fig. 41**). They are all composite objects made from iron and copper alloy sheet metal riveted together. With four exceptions, they are largely similar in construction. The majority of the cauldrons are made in four main sections: rim, iron band (A), copper alloy band (B) and bowl (C) (**Fig. 42**). The exceptions are those cauldrons that have multiple A or B bands, or those with no band B. The design of the cauldrons combines the structural strength of the iron rims with the thinness, lighter weight and higher thermal conductivity of the copper alloy band and bowl.

There are significant characteristic differences in the detail of the technology, especially of the rim and band A, which allows them to be subdivided into further groups. The shape of the rim and angle of band A denotes the form of the cauldron as a whole and whether it is likely to have been u-shaped or globular.

Dogleg cauldrons

These are a very distinctive type of cauldron within the Chiseldon group and represent a large proportion of those found at the site – 7 of the 17 vessels found at Chiseldon (including cauldrons 1, 8, 9, 13, 14, 16, and 17), which may indicate that they are a locally produced type (**Fig. 43**). The iron rim and band A found at Letchworth, Hertfordshire, is the only other cauldron of this type that has so far been catalogued (Moss-Eccardt 1965; 1988; Joy 2014). They are characterised by a hollow rim (type 1) attached to iron band A that curves inwards to form a dogleg just below the rim, creating a shoulder below which the sides of band A are convex (**Fig. 44**). It is possible that the carination in the band made it more dimensionally stable. The diameter of band A at the rim and at the A/B join is similar if not the same. This type of cauldron is also characterised by a tri-ribbed handle attachment. The carination of the dogleg and the ribbed handle attachment are reminiscent of the form of earlier Bronze Age copper alloy cauldrons and may be a continuation of form but the technology, materials and details of construction of the earlier Bronze Age and these later cauldrons from Chiseldon are distinctly different (Joy 2014).

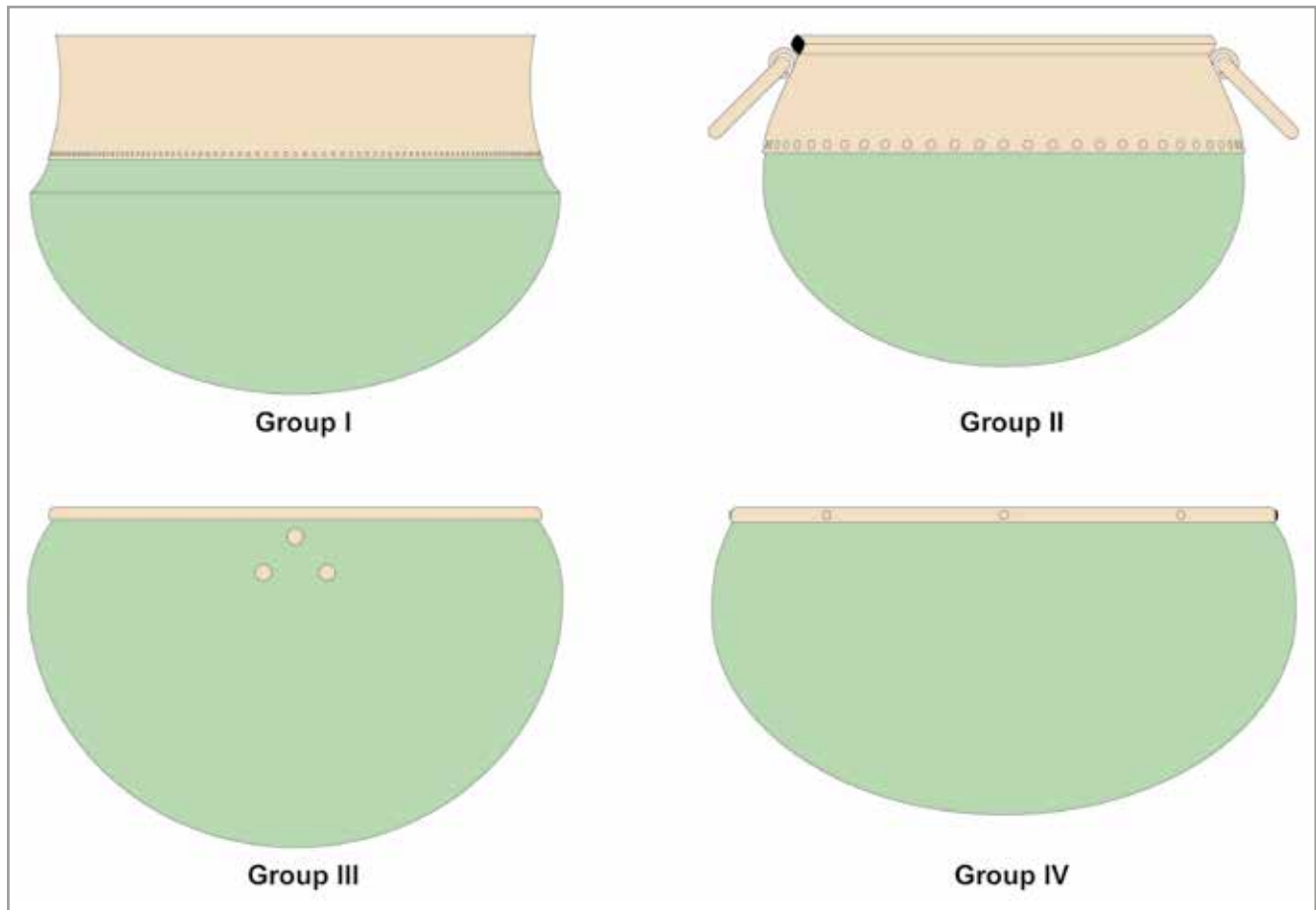


Figure 41 Cauldron typology (after Joy 2014)

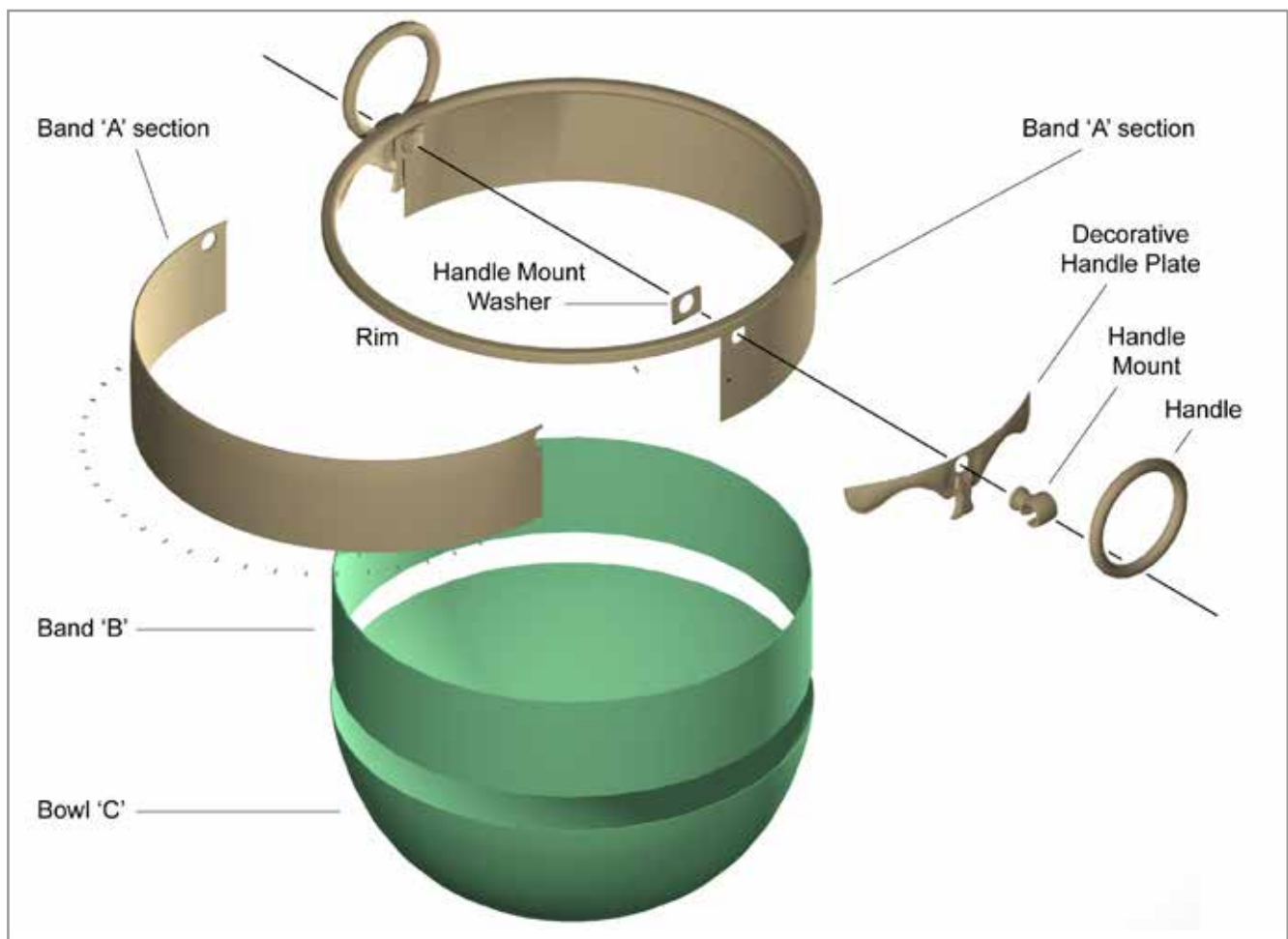


Figure 42 Illustration outlining terminology used for different parts of the cauldrons

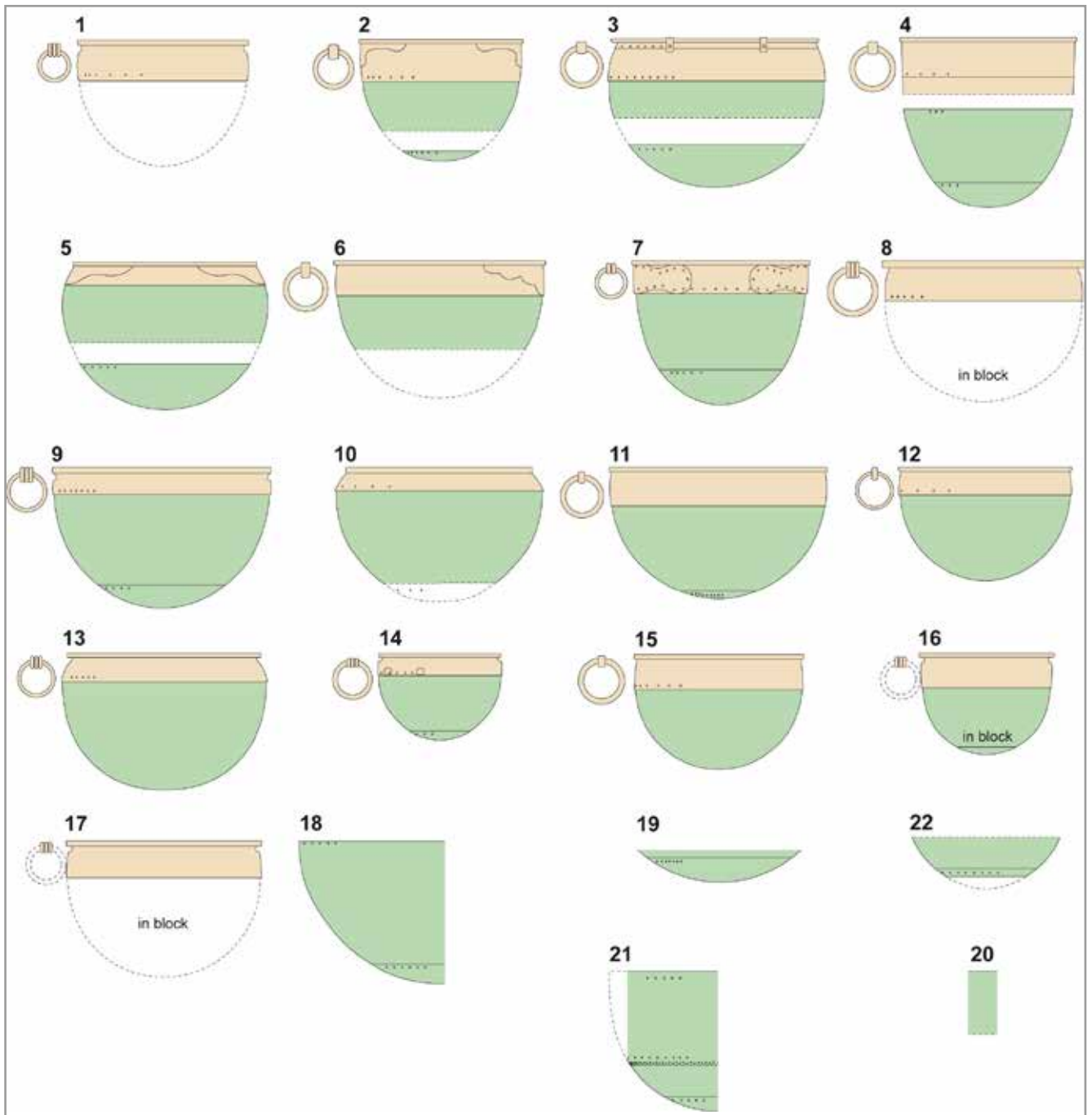


Figure 43 Scale drawing of cauldrons

Straight convex and flaring convex

The rim construction is similar on ten of the cauldrons from Chiseldon, and these are harder to subdivide into groups. While many of them have distinct differences in the severity of the flare to band A, including both straight convex and flaring convex bands (see **Fig. 44**), variations in degree of flare may to some extent be accidental rather than intentional. Additionally, the presence of decoration on band A (all three cauldrons with decorative handle plates fall into this category) may not indicate a difference in type. Therefore, subdividing this group of cauldrons on technological grounds may be misleading and any distinction based on the flare of band A is for descriptive purposes only (see also Joy 2014, 329).

‘Straight convex’ describes those cauldrons where band A comes out of the rim at a straight angle, with a varying degree of convex curve to the band, but the diameter of the

band at the A/B join is no wider than the diameter at the rim (see **Fig. 44**).

‘Flaring convex’ cauldrons often feature a lip around the exterior that is wider than that of the interior of the rim, while the angle of the iron band flares outwards with the diameter of band A at the A/B join greater than at the rim. There are three cauldrons with a varying degree of flare to band A (cauldrons 3, 5, and 10) (see **Fig. 43**), the most extreme being cauldron 10 where band A flares sharply from under the rim with the diameter at the A/B join 50mm greater than at the rim.

Cauldron dimensions

Alexandra Baldwin

The cauldrons range in size (external rim diameter) from the largest at 560mm (cauldron 9) to the smallest at 310mm in diameter (cauldron 14) and all correspond well with the size

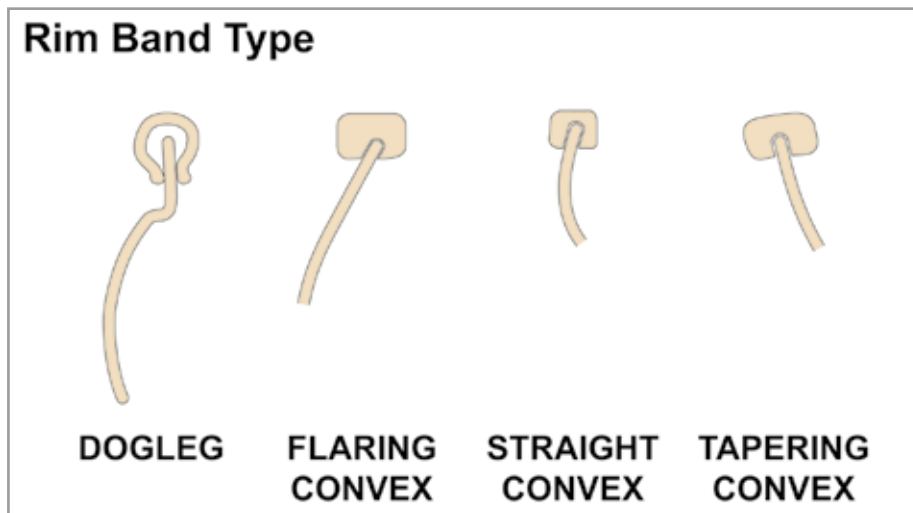


Figure 44 Band A typology

of other cauldrons from Group II (Joy 2014, fig. 7). Both cauldron 9 and cauldron 14 are dogleg cauldrons, the type which exhibits the widest range of sizes within the Chiseldon group with 250mm difference between the smallest and largest example. Those cauldrons with flared convex rims fall into a very small size range of 480–520mm with a maximum difference in size of only 40mm, although there are only three cauldrons within this category. Six cauldrons with a straight convex band A fall roughly into two groups around 450mm and 550mm.

Although the exact dimensions of the cauldrons are hard to calculate owing to their often incomplete and crushed state, the copper alloy sections, B and C, together appear to be roughly hemispherical, based on the diameter of the cauldron at the A/B join. The exceptions to these are two of the straight-sided cauldrons 4 and 7, where the width of the sheeting of band B and the diameter of the bowl C at the B/C join indicates that the copper alloy sections of these cauldrons were deeper than they were wide (see **Fig. 43**).

The proportions of the cauldrons in terms of the relationship between the dimensions of the iron and copper alloy sections range from a 1:3 to a 1:2 ratio. Whether this was intentional (either in terms of aesthetics or functionality) or unintentional coincidence is unknown, but Celtic art was sometimes made in consistent ratios (Spratling 2008, 188). Consistency in size and ratio could also be the result of learned methods of manufacture (Joy 2010, 151).

Cauldron structural elements

Alexandra Baldwin

Rim

Within the group of 17 cauldrons there are four distinct rim types. These have been classified as: hollow type 1; hollow type 2; solid type 1; and solid type 2 (**Fig. 45**).

Hollow rim type 1

This type of rim is present on cauldrons with tri-ribbed handles and a dogleg in band A, including cauldrons 1, 8, 9, 13, 16 and 17. Evidence from the rim cross sections of these cauldrons indicates that they were constructed by hammering a long strip of iron into a u-shape, placing this on the top of band A and then hammering the tube closed

around band A as the cauldron was rotated. This forms a hollow tubular rim with the lower edges turned out where it has been closed around the band. The edge of the rim on the interior of the cauldron is often flatter in profile, possibly indicating that the interior rim was placed on a rest while the exterior rim was hammered to close it over band A. Evidence from cauldron 9 indicates that this type of hollow rim may have been constructed by hammering the tube over an internal support or former to maintain the rounded outer profile. Remains of wood visible in the cross section of the rim between band A and the outer curve of the rim appears to be a half-round section of ash withy (*Fraxinus excelsior*) (Chapter 10) used to maintain the shape of the rim during its construction and attachment to the band (**Fig. 46**). It is possible that the hollow type 1 rims were all made in this way, but examination of the cross section of the other hollow-rimmed cauldrons from Chiseldon revealed no further examples; cauldron 9 has the only organic former to have survived within the rim cavity. Another example of the use of a wooden rod as an internal reinforcement has been found on a Bronze Age Class A cauldron from Barnacurragh, County Galway (Gerloff 1986) and the use of pliable wood in metalworking also has been observed in the manufacture of torcs (Cartwright *et al.* 2012).

The metal analysis carried out (Chapter 8) revealed no signs of quenching for this type of rim, indicating that closure onto the band was achieved manually with tools. The attachment of the rim onto band A appears to be largely a mechanical fixing as the angle of the top of band A flares out from just below the rim. There is, however, evidence of a rivet through the rim and band A of cauldron 1, possibly the remains of a fixing to hold the rim in position. This rivet does not show up on X-ray due to the poor preservation of the iron of the rim, but a ghost of the rivet head is present in the corrosion on the exterior of the rim. The condition of the rest of the rim of cauldron 1 is highly mineralised and not well-enough preserved to discern any other rivets, and no fixings of this kind have been found on any of the other type 1 hollow-rimmed vessels.

Hollow rim type 2

This type of rim is present only on cauldron 7, which has several unusual features. The rim of cauldron 7 is hollow and

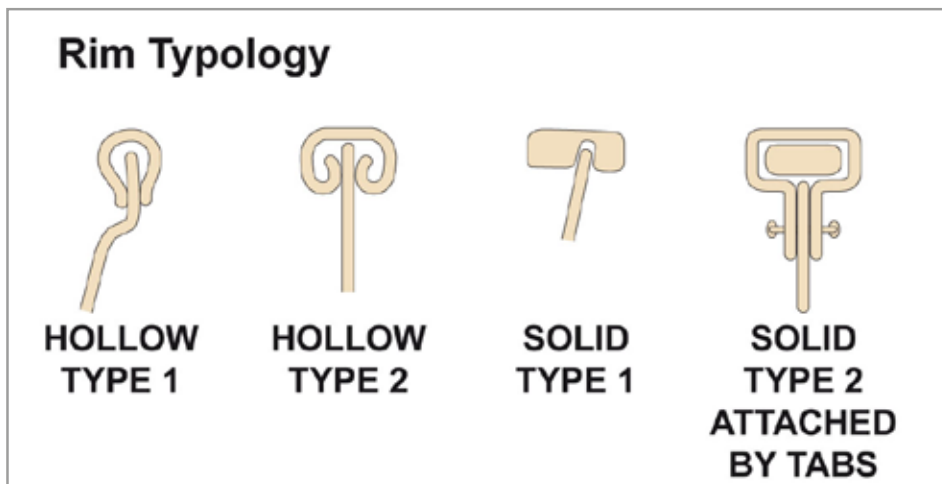


Figure 45 Illustration of different types of rim cross sections present in the Chiseldon group

was made from a strip of iron curved to form a tube and hammered closed onto the top of band A. It differs in construction from the type 1 hollow rim, as rather than curving out, the edges of the tubular rim curl under, helping to support its hollow form, as seen in cross section (see **Fig. 45**). Additionally, it can be classified as a distinct type, rather than an unintentional variation of hollow rim type 1, as it is present on a straight-sided cauldron.

Solid rim type 1

This type of rim is present on both straight convex and flared convex cauldrons, including cauldrons 2, 4, 5, 6, 10, 11, 12 and 15. It is characterised by a rim of solid sub-rectangular cross section often with rounded interior angles and squared exterior angles. Band A is inserted into a groove in the underside of the rim by approximately 7mm and then the rim was closed onto band A by hammering, quenching, or a mixture of both (Chapter 8). A variation of this solid rim type is the decorated solid sub-rectangular rim of cauldron 2. A double groove runs horizontally around the outer face of the rim, possibly made with a file or chased with a chisel after it was fixed into position.

Solid rim type 2

This rim type is characterised by a solid rectangular cross section held in place on band A by the use of four clips which extend over the rim and are fastened with rivets through the A1/A2 join. This type of rim only occurs on one cauldron within the group, cauldron 3, and is an unusual rim construction. It is possible that it may be a replacement or later addition to the cauldron as this would be the easiest way to replace a rim on an already fully made cauldron. Analysis of the composition of the iron from the rim and band A1 supports the idea that the rim may have been a later addition (Chapter 8).

Band A

Single band A

Evidence for the construction of band A is often hard to discern owing to the fragmented condition of the cauldrons. The majority of cauldrons present in the Chiseldon group have a singular iron band A that is inserted directly into the rim at the top and attached to the copper alloy band B at the bottom. The form of band A can be subdivided, as discussed



Figure 46 Remains of mineralised ash (*Fraxinus excelsior*) inside the rim of cauldron 9 (extent of mineralised wood indicated by dotted outline)

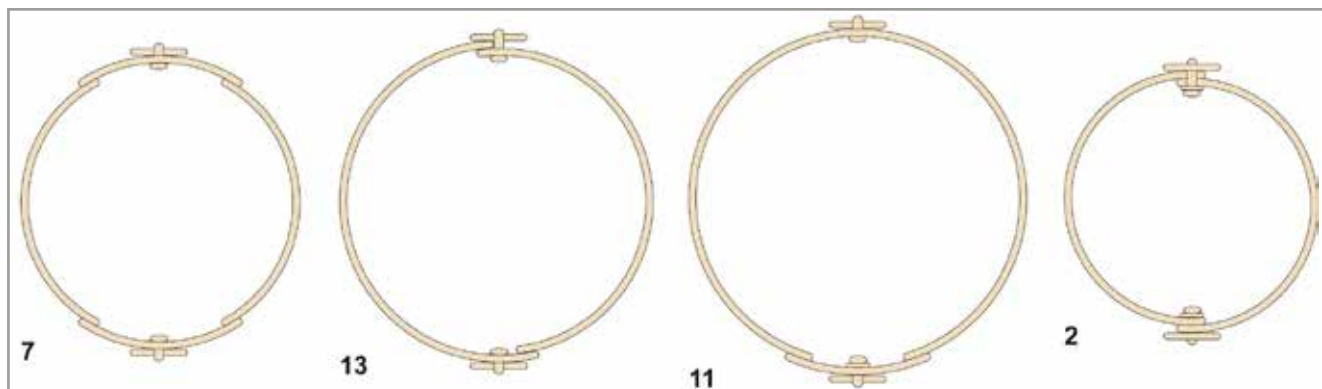


Figure 47 Illustration of band A construction

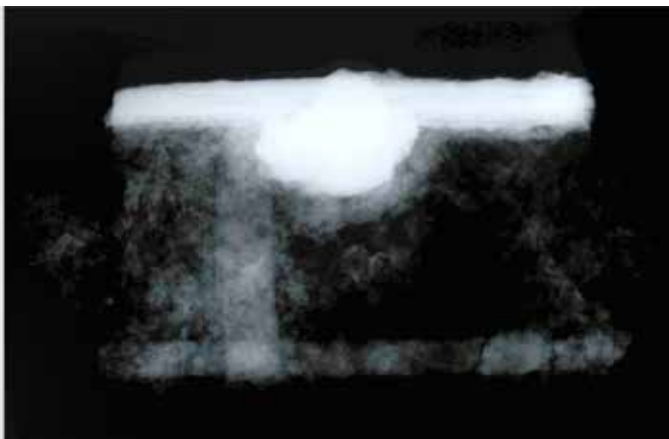


Figure 48 Photograph and radiograph of a fragment from band A of cauldron 4 with the band overlap visible to the left of the handle attachment

above, namely: dogleg; straight convex; and flared convex.

Multiple iron bands A1/A2

There are two exceptions to the single band A form, cauldrons 3 and 4, which have a double iron band – A1 and A2. Cauldron 4 has unusually wide iron banding, with A1 87mm wide and riveted to the exterior of A2, which, although incomplete, is greater than 51mm wide. This makes the total width of the iron band greater than 138mm, compared to an average for the rest of the cauldrons of 74.5mm. Metals analysis of samples from both A1 and A2 show distinct similarities in metal composition, lending weight to evidence from technological examination that both A1 and A2 are contemporary with the construction of the cauldron (Chapter 8).

The iron banding of cauldron 3 has a very narrow A1 band of 17mm and band A2 at 85mm. A1 is riveted to the exterior of A2 and with the unusual rim construction (discussed above) may be a later addition or repair. This is supported by the unusual addition of trapezoidal patches with two vertical rivets which act as reinforcements on the interior across the A1/A2 join and alternate with the four clips attaching the rim to bands through the A1/A2 join.

Band A sections

The iron of band A was made in sections and riveted together with vertical joins. On the majority of the cauldrons

band A appears to have been made in two sections with the overlapping joins near the handles.

Two section join aligned with handle

The construction of band A on cauldron 2 (straight convex band with decoration) is well thought out with a wide overlap at each handle. The joins are visible either side of the handle on the interior and exterior, with the handle attachment penetrating directly through the overlap. This is a clever design in which the plate overlap adds additional support for the weight of the handles, and the handle attachment provides additional fixing for the two sections of band A (**Fig. 47**). The construction of Class A ‘Atlantic Type’ cauldrons dating to the Bronze Age (although made solely of copper alloy) and the Iron Age example from Baldock all have the vertical riveted join between sections of the upper band positioned at the handles (Gerloff 1986; Stead and Rigby 1986).

Two section join aligned to sides of handles

The majority of other cauldrons, irrespective of type, appear to have the plate overlaps to one side of the handles. Typically, the overlap is about 20–30mm to one side of the handle attachment with an overlap of 8–10mm. An X-ray of cauldron 4 clearly reveals the overlap in band A1 to one side of the handle; however, the iron is too corroded to indicate the location of the rivets which must be present to secure the join (**Fig. 48**). The joins between iron sections are well preserved on cauldron 13. At the north handle the join is

adjacent to the handle on the exterior and is visible 3mm from it on the interior. The overlap is joined with 4mm square iron rivets with a rivet washer on the exterior (**Fig. 49**).

Sections of unequal length

On three of the cauldrons (3, 7 and 11) band A is made in four sections or two sections of unequal length, with joins apparent on both sides of one or both of the handles (see **Fig. 47**). Cauldron 7 appears to have an unusual construction. Band A has been made in four sections with the handle attachments mounted to exterior plates with decorative curved ends and domed rivets. This is well preserved on one side of the cauldron, but the other side is highly fragmented and evidence of a similar matching configuration at the other handle comes from disassociated fragments.

Cauldron 11 appears to be made in two sections with both joins visible on the interior 90mm and 110mm each side of the east handle with a riveted overlap of 15–20mm, with the east handle mounted on an external plate. The iron is well preserved and has been cleaned, but no further joins are visible on the rest of the band. Band A, therefore, appears to have been made of two sections of iron, one 200mm long and the other approximately 1527mm long (see **Fig. 47**).

The preservation of the iron from band A, however, is not uniform and for many of the cauldrons the overlap at only one of the handles is preserved with the other side either obscured by corrosion or missing owing to the fragmentary condition of the band. This is the case for cauldrons 9, 10, 12, 14 and 15. For cauldrons 1, 5, 6, 8, 16 and 17 the number and nature of joins to band A is unknown, owing to the condition of cauldron 1, and for the rest because band A is either completely or partially unexcavated in the two remaining soil blocks.

Decorated handle plates

Decoration on the iron work of band A is present on three cauldrons (2, 5 and 6) in the form of separate plates extending below and to each side of the handle mount. Each decorative plate appears to have been made in one piece from a thin sheet of iron which is riveted onto band A. The raised decoration on the plates has possibly been formed by the repoussé technique with the metal hammered from the reverse side to create the basic shape and then further detail chased in from the front to add definition. Alternatively, the complex decoration could have been carved into a former made of material such as wood or resin, and then the iron sheet hammered into this to create the decorative relief. This method would be far quicker than making the plates individually, especially for the complex patterning of cauldrons 5 and 6 which is almost identical on both sides of the cauldron. Comparison of the laser scans of the two decorative plates from either side of cauldron 6 reveals that the decoration is extremely close in design and the use of a former is possible (Stephen Crummy pers. comm.). The thinness of the raised decorative iron plate with a void between it and band A can be clearly seen in a cross section of cauldron 2 band A (**Fig. 50**). Residue within the void was sampled to test for any kind of 'filler', which may have been present to support the decoration and hold its shape;



Figure 49 Vertical join in band A of cauldron 13 secured with square iron rivets, and with domed copper alloy rivets along the A/B join

however, residue analysis revealed that the substance within the void contained high levels of ruminant animal adipose fat, probably food residues from cooking (Chapter 9).

The level of detail and design of the decorative plates extend down to the placement of the rivets that attach them to band A. The 'cattle head' decoration from cauldron 2 is riveted to band A through the raised centre of the ears and at

Figure 50 Cross section of the iron rim, band A and decorative handle plate of cauldron 2



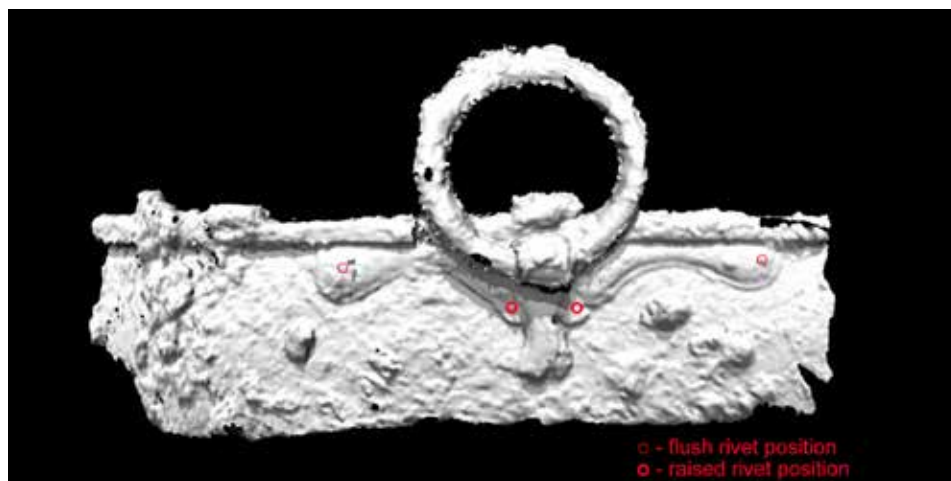


Figure 51 Rivet positions on the decorative plate of cauldron 2

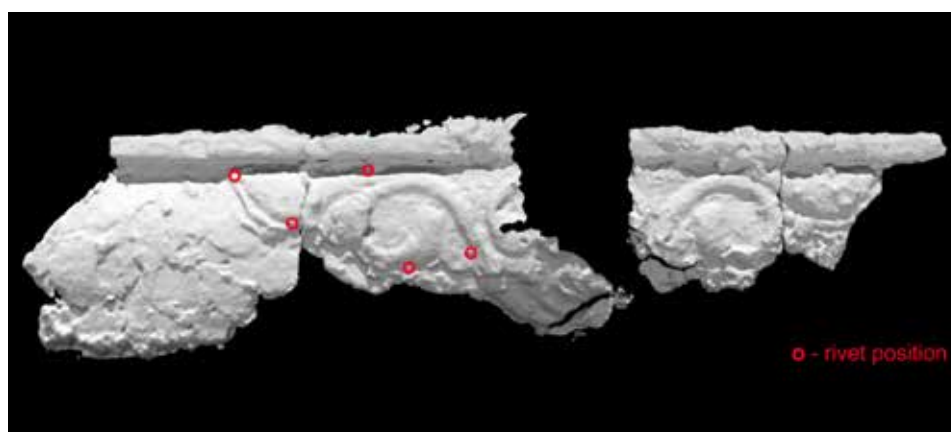


Figure 52 Laser scan of decorative handle plate of cauldron 6 indicating the location of visible rivets

the eyes and nostrils. The rivets at the centre of the raised lobe that form the ears are hammered flush, which must have been hard to achieve without flattening the unsupported raised plate, while those at the nostrils and eyes have been left domed, suggesting that their positioning was deliberate and forms part of the decoration as a whole (**Fig. 51**).

On cauldron 6 the rivets are positioned around the outer edge of the decorative plate adjacent to the scalloped edge and at the top edge where it butts up to the rim (**Fig. 52**). The rivets are approximately 2mm in diameter and raised with square heads, which indicates that they may have intentionally formed part of the decorative scheme as they were certainly visible and, as they have been riveted into recessed areas of the decoration, it would have been possible to hammer them flush. Unfortunately, owing to the poor preservation of the edge of the thin plate, it is unknown if this rivet distribution is mirrored on the decorative plate on the other side of the handle. The rivets securing the decorative handle plate to band A of cauldron 5 are visible as flush square-headed rivets located in the flat areas between the tendrils just below the rim. Although there may have been rivets along the lower edge of the decorative plate these are not visible either after removal of corrosion from the surface or in X-rays.

Handle mounts

The handles were attached in a similar way for all of the cauldrons. The handle mount is formed of either a plain, or in the case of the hollow type 1/dogleg group, a tri-ribbed

circular band. The band forms an open loop on the exterior of the cauldron through which the handle passes. The upper end of the handle mount passes through a hole in band A, just below the cauldron rim, and is domed over a washer on the interior (see **Fig. 42**). The handle mount is circular in cross section where it passes through the band of the cauldron. This design with a circular shank and a washer on the interior, along with evidence from the angle of some of the handles during burial, strongly suggests that this method of handle attachment allowed both a 180-degree elevation and 360-degree rotation of the handle-rings. The free rotation of the mounts would have allowed the cauldrons to pivot and be tipped when suspended by their handles. This would have been a significant advance in technology over the earlier fixed handle, which only lifted 180 degrees into the up or down position. The cauldron from Baldock has handles of a similar tri-ribbed design (Stead and Rigby 1986), but unlike the examples from Chiseldon and Letchworth the handle attachment of the Baldock example is fixed on the interior of the cauldron at three points and would not have been able to rotate.

Handle washers on the interior of the vessel vary in size and shape and are used to spread the load along band A and distribute the forces or pull on the handle when hanging. The larger handle washers also act as a strengthening plate to support the handle and vertical joins in band A. Smaller washers may also have acted as spacers between band A and the rivet ensuring the free turning of the handle. Cauldrons 10, 5 and 13 all have handle washers which are riveted to the interior of band A. Cauldron 5 has two oval handle washers



Figure 53 Tri-ribbed handle mount of cauldron 14 with handle stop at the lower left and area of damage and repair to band A on the right

secured to band A with five rivets around each curved side. The rivets appear to go through to the front of the decorative handle plate, indicating that the handles and handle plates were attached after the decoration had been applied to the exterior of band A. Cauldron 13 has additional support plates which are riveted to the interior of band A and extend either side of the handle mount between the handle washer and band A.

Handles

The handles have a fairly small size range, from 96mm to 130mm in diameter with a circular cross section of 8–15mm. This fits well with the handles presented in Joy's (2014) catalogue where the external diameter of handles ranges between 80 and 120mm.

The size of the handle does not correlate to the size of the cauldron and there seems to be no proportional relationship between the two (see **Fig. 43**). This is notable on the smallest cauldron, 14, where the handles are of an average size – 100mm in diameter. Cauldron 14 has an iron band A of 54mm in width and the handle hangs down well below this, the bottom of the handle extending onto the copper alloy of band B. Two hexagonal handle stops (25mm in diameter and 5mm deep) have been riveted to each side of the bottom of band A to stop the handle damaging the copper alloy base section (**Fig. 53**). Handle stops also appear on the cauldrons from Baldock and Letchworth (Moss-Eccardt 1965; 1988; Stead and Rigby 1986; Joy 2014). The form and position of the handle stops on the cauldron from Baldock are different to those of cauldron 14, whereas those on the example from Letchworth seem to be a direct parallel.

Analysis of the handle from cauldron 4 revealed that it was made from wrought iron. Slip lines along the external circumference of the circular cross section indicate that it was made by repeatedly hammering an iron bar while it was rotated (Chapter 8). Radiographs of the best-preserved handles (from cauldron 8) show evidence for a forge-welded join (**Fig. 54**). It is likely that this method was commonly used to manufacture handles, but does not show up on

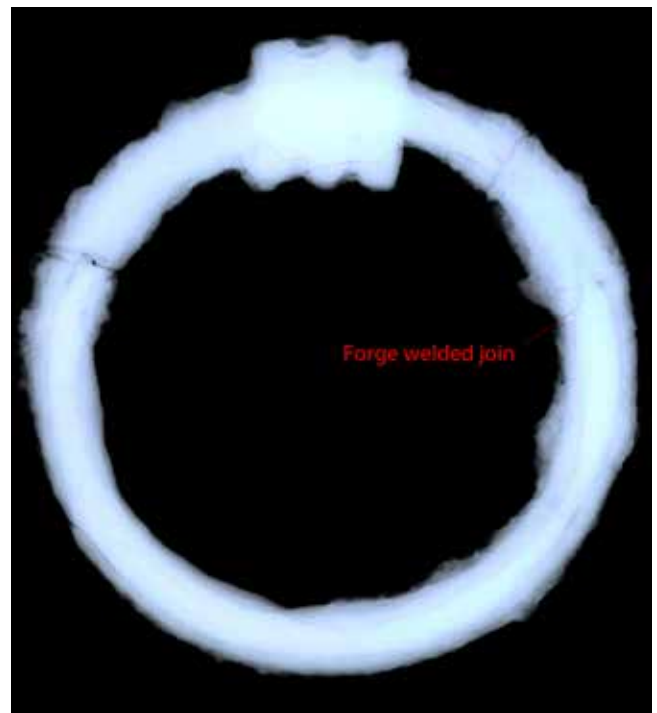


Figure 54 Radiograph of the north handle of cauldron 8 showing the forge-welded join

X-rays of the rest of the cauldrons due to the highly corroded condition of the iron. Additionally, corrosion patterns in the handle of cauldron 15, and the manner in which it had corroded along impurities, revealed a similar overlap to that visible in the X-ray of the handle from cauldron 4.

Band B and bowl C

From evidence gathered during excavation and conservation it appears that the copper alloy sections were all constructed in a similar manner. The majority of the cauldrons feature a two-part copper alloy construction consisting of band B and bowl C, except for cauldron 12 and 15 where the copper alloy comprises one large bowl with no



Figure 55 Scalloped edge and double row of riveting along the B1/B2 join of cauldron fragment 21

band. Examination of Joy's (2014, app. b) catalogue shows that both types of construction were used elsewhere.

With the exception of cauldron fragment 21, the B band of all vessels is made of one horizontal section. On fragment 21, there appears to be an additional B section to the vessel. This large copper alloy fragment was not, as far as we can tell, placed in the burial as part of a complete cauldron; however, it comes from an area of the pit disturbed by the metal detector user so its exact location or condition on burial is unknown. Fragment 21 appears to be made with two horizontal B sections and includes B1 (240mm deep from the A/B join to the B1/B2 join) which is attached to a section of B2 (80mm deep) with rivet holes from the B/C join at its lower edge. This cauldron also appears to be unique as the bottom edge of B1, where it is riveted to the exterior of B2, is scalloped. Each scallop is 14mm wide and 7mm deep with two offset rows of domed rivets at 16mm intervals (**Fig. 55**). The relative depth of the bands and the curvature of the B1/B2 and B2/C joins indicate that the copper alloy sections of this vessel may have been approximately 560mm in diameter at the top of band B and 350mm deep from the top of band B to the bottom of bowl C.

The extreme thinness of the copper alloy of band B means that in many cases this is the most poorly preserved part of the cauldron. Many of the bands are fragmented and partial. However, there is no evidence for a vertical join in band B on any of the cauldrons present in the deposit. Cauldrons with complete band B sections remaining (including cauldrons 11, 3, 13, 14 and 7) indicate that the band was made without joins, and not of many sections of copper alloy riveted together as with vessels of an earlier date. Additionally, the complex curve of band B indicates that it was probably initially created as a bowl.

This raises the possibility that, where the copper alloy portion of the cauldrons are made in two sections band B and bowl C, either C is part of the intentional design, or it is a repair. At what point the bowl was attached, whether during construction or due to later damage, is not clear. It is possible that as the metal was thinned during the sinking or raising process the base became damaged and a repair was

made rather than starting from scratch. The damaged section may have been trimmed off, as evidence of over-cuts from shears or snips along the lower edge of band B at the B/C join on many of the cauldrons reveals, and another bowl created to fit the void. However, bowl C may have been added at a later date as a repair (discussed below).

All the bowls are riveted to the exterior of band B, except for cauldrons 12 and 15 where the copper alloy section consists solely of a bowl and is riveted directly to the interior of band A. Where the copper alloy section of the cauldron is made in two pieces, the dimensions of the bowls vary greatly in size and depth. The largest are on cauldron 3 and 5, where the bowls are approximately 130mm deep and 450mm in diameter at the B/C join, and the smallest is cauldron 11 with a bowl 30mm deep and 170mm at the B/C join. The proportions of the bowls do not seem to be determined by a ratio with bands A and B, and the extent of the size of the bowl it was possible to manufacture, as shown by cauldrons 12 and 15, could be large. Additionally, the sheet metal of the bowl is often thicker than band B suggesting that the possible working limit of the metal had not been reached. The measurements of sheet metal thickness (Chapter 8) do not reflect this fully as many of the samples were taken from the band and bowl close to the B/C join. These details of construction seem to suggest that, for each cauldron, bowl C was made specifically to fit, and therefore made after, band B.

Analysis of the metals is inconclusive in proving when the bowl was attached to the base of the cauldron. Of those cauldrons analysed, the composition of the metal of the band and bowl indicate that they were likely to have been cast separately (Chapter 8). Fragment 19, which was placed in the deposit as a fragment consisting of bowl C and the remains of band B, indicates that the copper alloy of band B and a patch over a stress fracture on the bowl are very similar in composition. Again this analysis is inconclusive as it could mean that either the bowl was applied at the time of manufacture, or that the bowl was applied as a later repair and offcuts from the damaged base section were used to repair the newly manufactured repair bowl.

Repair during manufacture (Table 2)
Alexandra Baldwin and Jody Joy

Patches across stress fractures

Diagonal or v-shaped splits are evident along the edges of many copper alloy sheet components. They are characteristically caused by the overworking of the metal and are due to insufficient annealing of the copper alloy during shaping. They are located at the upper edge of band B, and less frequently at the edge of C at the B/C join. The stress fractures were repaired with either finely shaped scalloped-edged or fancy patches, or neatly cut triangular patches. On three of the cauldrons (5, 10 and 15) the stress fractures at the upper edge of band B have been neatened by trimming into a u-shape before the patch was applied to the interior (**Fig. 56a–b**). Evidence from the riveting sequence indicates that the patches to the stress fractures were repaired before the A/B or B/C joins were made and the separate sections assembled.

Fancy patches

Of the 17 cauldrons within the Chiseldon group, 8 have decorative copper alloy ‘fancy’ patches which appear to have been applied at the time of manufacture (including cauldrons 5, 6, 7, 9, 10, 11, 12 and fragment 18). These carefully cut and filed patches have a variety of different forms ranging from scalloped-edged patches to those of a more complex design (**Fig. 57a–b**). While patching on cauldrons is relatively common, the use of scalloped and s-shaped patches is only present on one other cauldron, from Ballyedmond, Galway (Joy 2014). The fancy patches are, with the exception of three patches on cauldrons 9, 11 and fragment 18, positioned over stress fractures to the metal at the top of band B along the A/B join. The location of these patches along the A/B or A/C join, attached to the interior and positioned one-third to a quarter of the way down the cauldron, suggests that although they are decorative, they would have been hidden from view except to those looking inside the vessel.

Cauldron	SF	Scalloped	Fancy	Plain patches
1	5	–	–	–
2	7	–	–	7
3	8	–	–	5
4	9	–	–	4
5	10	3	–	–
6	11	1	–	–
7	13	–	cloud	2
8	82	–	–	–
9	87	–	comma	–
10	105	4	–	–
11	123	3	claw, fish	2
12	149	5	–	1
13	150	–	–	–
14	153	–	–	–
15	154	–	–	26
16	UK1	–	–	–
17	UK2	–	–	–
18	4	4	s-shaped	–
19	16	–	–	4
20	23	–	–	4
21	58	–	–	2
22	9/17/	–	–	–

Table 2 Types of repair to each cauldron carried out during manufacture

The scalloped patches are generally trapezoid or triangular in shape with a straight edge along the A/B join and scalloping down the remaining sides. The patches are most often quite small, averaging 30–40mm in length; however, the largest scalloped patch on cauldron 12 is sizeable at 190 × 65mm covering a large split which has been trimmed on the exterior. The copper alloy section of cauldron 12 is made in one piece without a band B, which



Figure 56a–b The upper edge of band B of cauldron 10 with: a) fatigue crack trimmed into a u-shape on the exterior; b) fancy patch on the interior



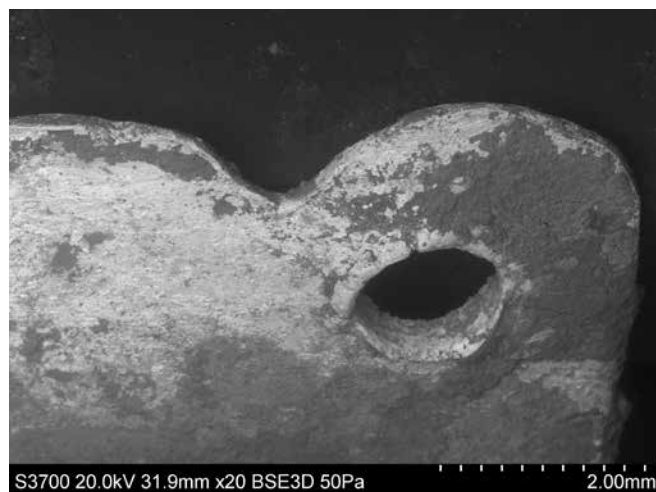
Figure 57a–b Different types of fancy patches present on cauldrons from the Chiseldon group including: a) ‘claw’ and ‘fish tail’ patches on cauldron 11; b) s-shaped and scalloped patches on cauldron fragment 18

may explain the failure of the sheet metal during working and the size of the patch.

As well as examples of triangular or trapezoidal scalloped patches other ‘fancy’ patches of various forms are present on cauldrons 7, 9, 11 and fragment 18. Cauldron 7 has one cloud-shaped patch on the interior of the cauldron at the base of a fatigue crack on band B. In addition to scalloped patches, one of the stress fractures on fragment 18 is covered with a very small and neatly made s-shaped patch and there is an irregularly shaped triangular scalloped patch on the interior of and half way down band B. The latter may be a later addition as it is not as finely made as the patches along the A/B join. Cauldron 11 has three fancy patches covering stress fractures in the sheet metal. These are shaped like a claw and a fish, and a further patch, sadly too corroded to determine a shape, runs vertically half way down band B (see **Fig. 57a–b**).

Scalloped-edged and fancy patches are predominantly present on either the straight or flared convex cauldrons, with six out of a total of ten having them, and on three of the four cauldrons with a decorative band A (cauldrons 5, 6 and 7). Additionally, there are six further scallop-edged patches on fragments discovered by the metal detector user or from unstratified contexts. With the exception of cauldron 9, fancy patches are not present on any of the dogleg cauldrons.

Figure 58 Scanning electron microscope (SEM) image of a fancy patch from cauldron fragment 18 with evidence of filing along the scalloped edges



The patch on cauldron 9 is a comma-shaped patch with scalloping of 2mm. Its location half way down band B is unusual, as is its presence on a dogleg cauldron, and it is unclear whether it is a repair to a manufacturing fault or due to damage incurred later.

The decorative patches tend to be very neatly made with the securing rivets passing through the centre of the scallops and hammered flush on the exterior surface of the B band to reduce their visual impact. The scalloping is regular and often very fine, with some scallops as small as 2–3mm: for example, those on cauldron 9 and fragment 18. This would have been both time-consuming and probably quite difficult to accomplish. It is unknown how the scallops were cut, whether with snips or shears, or if they were punched out with a curved-edged tool. However, due to slight irregularities in the size of individual scallops they were most probably cut with snips or shears. The edges of several of the scallops show signs of filing (**Fig. 58**). The SEM examination of a scalloped patch from fragment 18 revealed filing marks along the scallops while a tapering copper alloy scalloped-edged patch 25 × >30mm in size from a detached fragment from cauldron 5 has file marks on the edges as well as the flat surface of the patch, indicating the scallops were probably cut, then filed vertically to remove over-cuts and irregularities and then filed horizontally across the surface to remove burrs.

Plain patches

Plain triangular patches over stress fractures are present on many of the cauldrons, including cauldrons 2, 3, 4, 7, 11, 12, 15 and fragment 19. They are neat, often with sharply cut edges as opposed to the filed edges of the scalloped patches. Cauldron 15 has extensive patching over stress fractures at the top edge of the copper alloy section where it joins the iron, with seven triangular copper alloy patches and a total of 26 patches of both copper alloy and iron identified. The extent of the repair on the copper alloy may be explained by its one-piece structure and the fact that the copper alloy has been pushed to the limit to create a single-piece bowl. Patches to stress fractures on cauldron 2 have been neatly cut into geometric shapes including quadrilaterals, elongated octagons and truncated ellipses.

Patching at the edge of the bowl section at the B/C join is unusual, occurring only on cauldron 3 and fragment 19.

Patching to stress fractures at the edge of the bowl C on cauldron 3 is in the form of triangular-shaped patches on the interior. The patching to stress fractures at the edge of the bowl section of fragment 19 includes a tongue-shaped patch held in place with four rivets hammered flush on the interior and exterior (**Fig. 59**). The edge of the patch is between the B/C join indicating that it was applied to C before C was attached to B. Additionally a square patch on the bottom edge of B must have been applied over a fault in the metal at the time of manufacture as the rivets attaching the patch to band B do not penetrate C and so the patch must have been riveted to B before B was attached to C.

Other evidence of manufacturing repair

Damage to the cattle-headed decorative handle plate at the southwest handle of cauldron 2 was probably repaired at the time of manufacture. The right ear was repaired with an overlap in the decorative iron plate with two sets of iron rivets arranged vertically either side of the join (**Fig. 60**). This may explain the difference in the dimensions of the two opposing handle plates with the two left ears similar in dimension with a length of 128mm but the right ear on the undamaged northeast escutcheon measuring 136mm and the damaged ear on the southwest plate measuring 121mm. The repair is very neat and the rivets flush with the surface of the metal, suggesting that the ear may have been damaged and repaired during the construction of the vessel. The bottom of the nose on the southwest plate also appears to have been damaged and repaired; the bottom section is missing and a rivet has been inserted through the tip of the nose to fix it down.

Evidence for techniques of manufacture

Alexandra Baldwin and Jamie Hood

The relative observed frequency of tool marks (including hammer and stake impressions, evidence for cutting, and file marks) on the iron and copper alloy surfaces of the cauldrons may be misleading as such ephemeral evidence relies on careful and detailed cleaning of the surface as well as on the surface of the metal being intact and not disrupted by corrosion. For this reason, tool marks have been observed on the copper alloy, but not on the iron, as the surface of the copper alloy is better preserved. In many cases it is possible that further evidence and detail of tool marks could be found with additional surface cleaning or more extensive X-radiography.



Figure 59 Tongue-shaped patch to a stress fracture at the interior edge of the bowl section of cauldron fragment 19

Manufacture of copper alloy sections

The copper alloy was smelted and then probably cast as a 'puddle' or blank and further thinned and shaped by working to create the sheet metal to form the cauldrons (Joy 2014, 338). The tool marks found on the surface of the copper alloy sheet indicate that the metal was reduced in thickness and then shaped by a combination of sinking and raising techniques (see Maryon 1938; 1949).

As described above, the lack of evidence for a vertical join in band B on any of the cauldrons suggests that this section of the cauldron was made in one piece and the bowl section C of some cauldrons added either at the time of manufacture or as a later repair, thus creating a two-part copper alloy base to the vessel of roughly hemispherical dimensions. Despite the large size of the vessels (the largest being cauldron 9 at 560mm) the copper alloy has been beaten out extremely thinly to the extent that, in some areas, it is approximately one-tenth of a millimetre in thickness. The metal of the bowl sections was consistently found to be thicker and less damaged than that of the B bands. It is



Figure 60 Riveted repair to the cattle-head-shaped decorative handle plate of cauldron 2

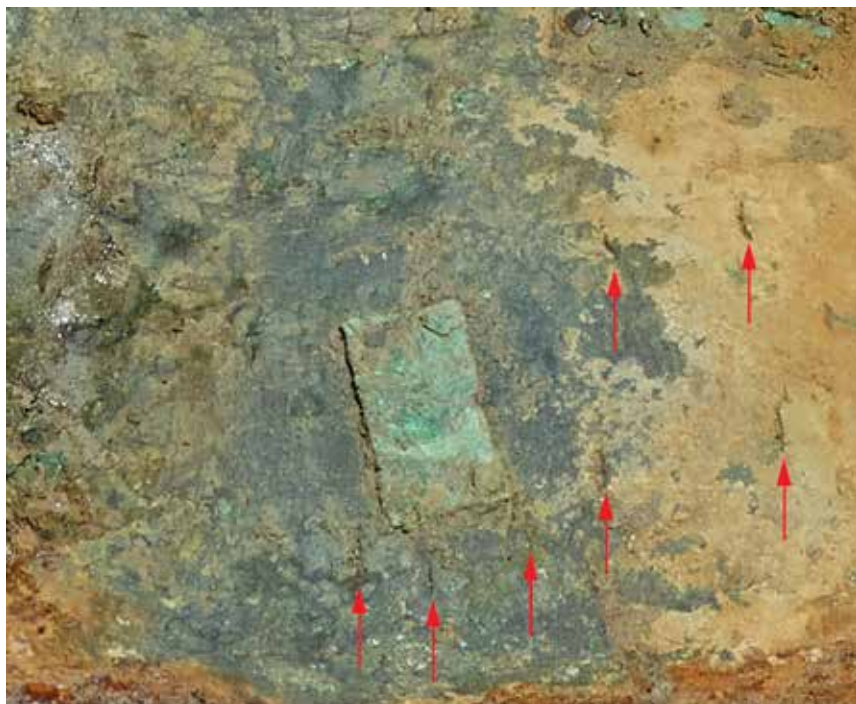


Figure 61 Small tears or folds to the metal on the interior of the bowl of cauldron 15 (indicated by arrows)



Figure 62 Tool marks typical of those from the use of a peening hammer on the exterior of cauldron 10

possible that the greater thickness of the bowl may have been an intentional design feature with the more substantial piece of metal positioned directly over the heat of a cooking fire. The thickness of the metal at the upper edge of the bowl at the A/B join compared to at the base of the bowl or the B/C join can also indicate the shaping method used. On band B of cauldron 13 the upper edge of B at the A/B join is thicker, at 1mm, than the bottom at B/C join, which is 0.5mm and is typical of the raising technique. This is interesting as it has previously been argued that sinking was more common because characteristic hammer marks in a spiral pattern have been observed on some cauldron bowls (Loughran 1989, 23–4; Joy 2014, 339).

Other evidence for techniques of manufacture includes tears to the bowl edges. The stress fractures common on the majority of the cauldrons at the A/B join are formed during

manufacture and are associated specifically with the raising process. Additionally, several small tears to the copper alloy sheet 5–10mm long which radiate vertically on the interior of the bowl of cauldron 15 and appear to be oblique to the metal surface are possible indications of the raising process where folds in the metal have been hammered out (**Fig. 61**).

Tool marks

Different tools and methods were used on different components of the vessels. Round dimples or elliptical tool marks are found most often on bowl section C and regular linear parallel impressions are present on some of the central bands B. Evidence from cauldron 15 where the copper alloy was made in one section, with the copper alloy bowl C joined directly to the iron band A, echo this observation.

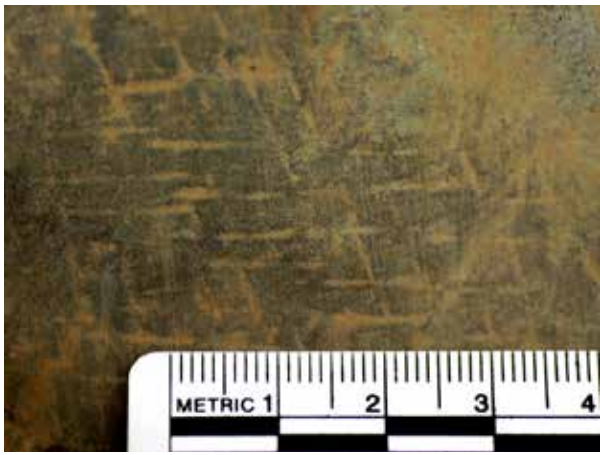


Figure 63 Linear tool marks on the interior surface of cauldron 4 band B

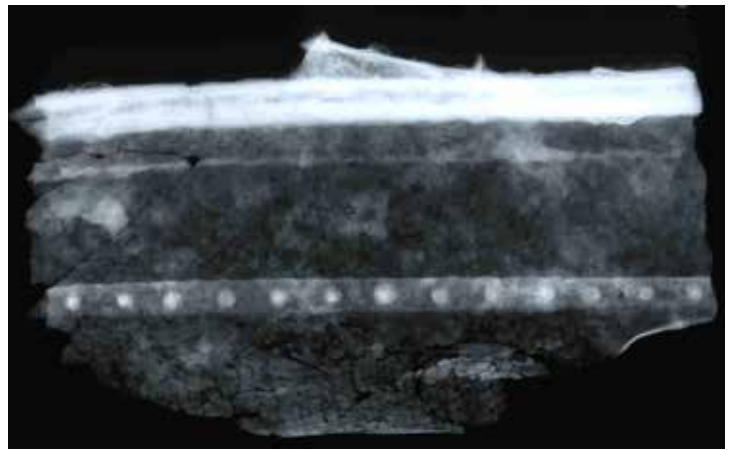


Figure 64 radiograph of a fragment of rim, band A and part of band B from cauldron 8 revealing tool marks on the copper alloy of band B

Cauldron 15 has dimpled hammer marks on the exterior base of the bowl and linear tool or stake marks up the sides in the interior of the cauldron with their length radiating from the centre of the bowl.

Elliptical marks from a peening hammer are evident on the outer surface of band B of cauldron 10 close to the B/C join (**Fig. 62**). The lengths of the elliptical indentations run parallel to the B/C join. A peening hammer is used to move metal around and indicates that metal was forced from the base to create the sides during the raising process. This evidence additionally supports the theory that band B was created as a bowl. Fragment 19 also has oval-shaped hammer marks on the exterior surface of the bowl section that run parallel to the edge and spread outward from the centre, presenting further possible evidence of the use of a peening hammer.

Linear tool marks are present on the internal and external surfaces of band B of the cauldrons including cauldrons 4 and 11, and fragments 19, 20 and 21 and in X-rays of the copper alloy of band B from cauldron 8 (**Figs 63–4**). The linear tool marks on the interior of cauldron 4 are indentations 5–10mm in length and 0.5–1mm wide (see **Fig. 63**). They run perpendicular to each other and diagonally to the orientation of band B. These linear or angular shapes on the interior are suggestive of stake marks and occurred as a result of the raising process. These marks occur when there are raised or indented areas on the otherwise smooth surface of the stake (usually a slightly domed section of wood) that the metal is placed over and hammered against during shaping. As the metal is hammered it will pick up any blemishes on the surface of the stake, which, as the metal is moved and repeatedly struck, will manifest as a series of regular marks. The evidence indicates that after initial sinking to create a rough shallow bowl the copper alloy of cauldron 4 was placed over a stake and worked from the outside. These stake marks were often removed during finishing processes, but as the metal of band B from cauldron 4 is a fraction of 1mm thick it is possible that finishing the surface would have been too risky and potentially led to damage to the sheet metal.

Linear tool marks are also present on the exterior of band B of some of the cauldrons and are possibly either from a sinking stump or tool marks from a square-faced hammer.

Linear tool marks on the exterior of fragment 20 run diagonally to band B, while those on the exterior of fragment 19 are both vertical and horizontal. Linear tool marks on the exterior of band B1 on fragment 21 are 3–4mm in length and run perpendicular to the band on the bottom third and parallel on the top two-thirds.

Cut marks

Evidence for the use of shears or snips can be found on the edges of sections of sheet and cut patches. Over-cuts, which are the steps formed at the edge of the metal by individual cuts with the shears, are found on the lower edge of band B of vessels 5, 9, 10 and 14 indicating that these edges were cut with snips or shears without further working of the edge (**Fig. 65**). Over-cut marks are possibly more evident on the bottom of band B at the B/C join edge of many cauldrons as the tight concave curve would be more difficult to cut and require the repositioning of the shears resulting in the over-cuts. The 'fresh' cut marks on the lower edge of band B also lend credence to the theory that band B was made as a large bowl and the damaged or overworked section cut away during manufacture or repair.

Figure 65 A bevelled edge and over-cut mark indicating the use of shears to cut the metal at the lower edge of band B of cauldron 10





Figure 66 (left) Marking out lines present on the exterior of the bowl C of cauldron fragment 19 indicating the position of the B/C overlap and the rivet spacing



Figure 67 (right) Marking out lines on cauldron 11 band B at the A/B join visible only in the radiograph

The lower edge of band B at the B/C join of cauldron 10 has a distinct bevelled edge that indicates it was cut with shears or snips with cutting edges that met. This bevelled edge is distinctly different from the sharp straight-cut edge present on the cut sections of other vessels, which would suggest that the metal was cut with shears, the cutting edges of which overlapped in a scissor motion.

Marking out lines

Evidence that the design and construction of the cauldrons was carefully considered comes from the presence of incised lines on the surface of the copper alloy. These ‘marking out’ lines were used to indicate the extent of the overlaps or position of rivets, or to mark the cutting line for sections which required trimming, and appear as faint inscribed lines in the surface of the copper alloy. In all cases the groove is shallow and rounded implying a pointed but relatively blunt tool was used to mark the surface and the lines were not engraved; the latter process uses a sharp v-shaped tool which removes metal to produce a channel. Marking out lines have been found on vessels 9, 11 and 12, on fragment 19, and on a fancy patch from fragment 18. The markings are so shallow that they are hard to distinguish and have only been discovered in areas where the preservation of the surface is extremely good and the corrosion and burial deposits have been cleaned back to the ‘original’ surface. It is possible that there are more cauldrons from the Chiseldon group with marking out lines that have not yet been discovered.

Lines on the exterior of the bowl of fragment 19 mark the overlap between bowl C and band B with a horizontal line running around the bowl 12mm from the edge. Additional vertical lines at regular intervals of 10–14mm indicate the position of rivet placements along the B/C join (**Fig. 66**). Marking out lines indicating the position of the overlap at the A/C join are also present on the interior of bowl C of cauldron 12. They are visible only in radiographs of cauldron 11 in the copper alloy at the top of band B along the A/B join, and align almost precisely with the line of the iron band, but are obscured on the object by corrosion and possibly by the iron band itself (**Fig. 67**).

The scalloped triangular fancy patch from band B of fragment 18 is interesting as marking out lines are scored into the surface of the copper alloy describing the shape along one side (**Fig. 68a–b**). Further parallel curves inscribed on the surface at the centre of the patch, possibly marking out scalloping, imply that the patch was cut from a fragment of scrap sheet used to practise other designs.

Cauldron assembly

Alexandra Baldwin

Construction sequence

All the cauldrons (except those with multiple A and B bands, or those with just A and C) have the same construction sequence. Band A was constructed and then the rim was attached, either by creating a hollow tube which is hammered closed over the band, or creating a solid rim and

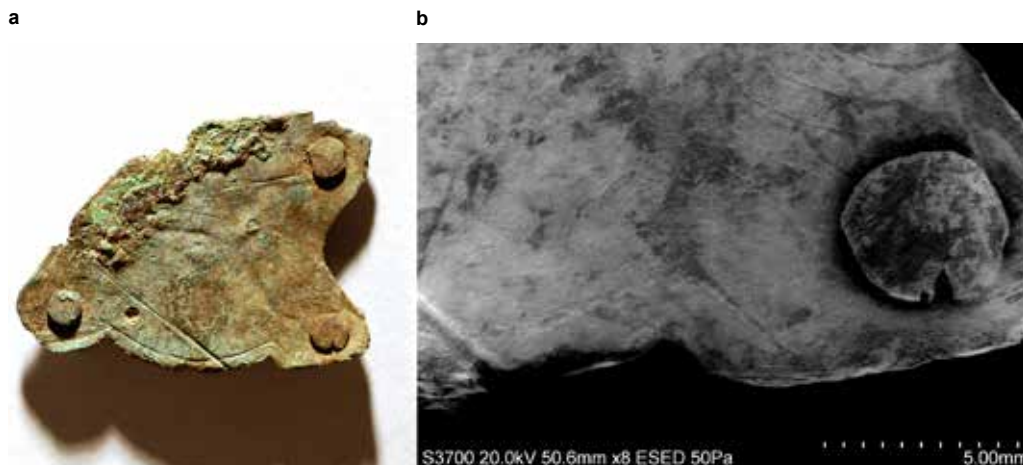


Figure 68a–b Scalloped patch located half way up band B on the interior of cauldron fragment 18 with marking out lines scored into the surface parallel to the lower edge of the patch and additional scalloped marking out lines above the right hand rivet visible in a) and b)

inserting band A into a groove before quenching the rim. The copper alloy was worked to create a hemispherical bowl of the required size. The base of the bowl was cut away if damaged during the working process. A separate bowl C was created and repairs undertaken to tears and faults in the edges of the copper alloy before riveting bowl C to the exterior of band B. The copper alloy section of the vessel was then attached to the interior of the iron band A. It is unclear at what point the handles were attached to band A, but presumably it would have been easier to work on the iron and copper alloy sections without the handles attached, so they may have been added last. The handle ring was made and the attachment constructed around this. A hole was punched through the iron band and the shaft of the handle attachment inserted through the hole before hammering it over a washer on the interior.

On those cauldrons with multiple banding of either A or B, the top of each successive band is riveted to the interior of the previous, so A2 is riveted to the interior of A1 and B1 riveted to the interior of A2 etc. Bowl C is always riveted to the outside of the copper alloy band B, but in the case of cauldrons made from a single copper alloy section the bowl C is riveted directly to the interior of band A (**Fig. 69**).

Riveting

Each section of the cauldron, apart from the rim attachment, is held together by rivets. The joins between sections of sheet metal seem to have relied solely on riveting. Residue analysis of material from between the joins of the sheet metal revealed no indication of a caulking material, only food residues similar to those preserved on the interior

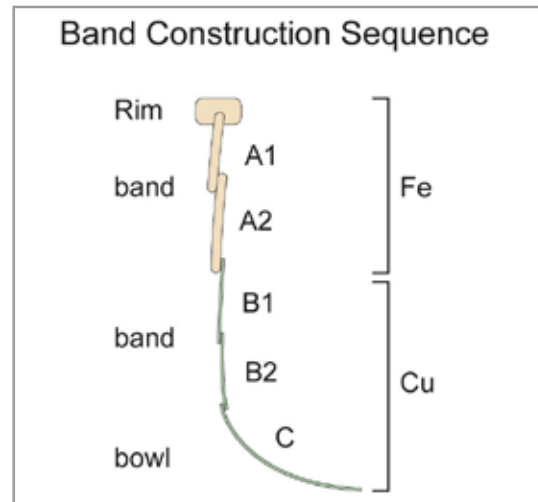


Figure 69 Construction sequence of multiple-banded cauldrons

bowl and exterior rim (Chapter 9). It is possible that after the initial use of the vessel food residues penetrated the join and created a watertight seal, meaning that when it was first used the cauldron was somewhat leaky.

The type of rivet (size, shape, spacing and whether flush or domed) varies greatly between cauldrons and even on the same cauldron (**Table 3**). Although the evidence is inconclusive, the neatness of the rivets on the exterior of most of the vessels suggests that they were made with heads and then inserted from the exterior. For rivets with domed or raised heads a former protected the exterior rivet head shape while the pin of the rivet was domed over on the interior. In many cases it is impossible to tell if the rivet holes were

Table 3 The types of rivets and their spacing along the joins between sections of cauldron

Cauldron no.	SF no.	A/B						B/C								
		Material	Spacing mm	Internal			External			Spacing mm	Internal			External		
				Size mm	Domed	Shape	Size mm	Domed	Shape		Size mm	Domed	Shape	Size mm	Domed	Shape
1	5	Cu	39	5	x	cir	5	y	cir	-	-	-	-	-	-	-
2	7	Cu	29	3.5	x	cir	5	y	cir	22	4	y	cir	2	x	cir
3	8	Fe	21–6	4	x	cir	5	x	sq	22	4	y	cir	6	x	cir
4	9	Cu	14–15	8	x	cir	-	-	-	16–18	2–3	x	sq	2–3	x	cir
5	10	Fe	38	5	y	sq	5	-	-	17–24	3–4	x	cir	3–4	x	cir
6	11	Cu	29–32	4	x	sq	4	x	cir	-	-	-	-	-	-	-
7	13	Cu	31	4	x	cir	5	y	cir	21	4–5	x	cir	3	x	cir
8	82	Cu	25	7	x	cir	5	y	cir	-	-	-	-	-	-	-
9	87	Cu	14	7	x	cir		y	cir	18	5	x	sq	3–5	x	cir
10	105	Cu	40–4	4	x	cir	5	y	cir	26–30	3	x	sq	4	x	cir
11	123	Cu	21–4	3	x	cir	2–3	y	sq	12	3	x	cir + sq	3	x	cir
12	149	Cu	-	-	-	-	-	-	-	26	3	x	cir	4	y	cir
		Fe	-	-	-	-	-	-	-	40–5	5	x	-	-	-	-
13	150	Cu	24–6	4	x	cir	5	y	cir	-	-	-	-	-	-	-
14	153	Cu	18	5–8	x	cir	5	y	cir	21	4	x	cir	3	x	cir
15	154	Cu	-	-	-	-	-	-	-	18–21	3	x	cir	5–6	y	cir
19	16	-	-	-	-	-	-	-	-	10–14	3–4	x	sq	2–4	y	cir
20	23	Fe	26–8	4	x	cir	4	x	cir	-	-	-	-	-	-	-
21	58	-	26	-	-	-	-	-	-	-	-	-	-	-	-	-

pre-drilled or punched as riveting has flattened out diagnostic distortions in the copper alloy sheet. Occasional incidences of displacement around rivet holes indicate that at least some of the rivets were punched through the copper alloy from the interior to the exterior, with the exception of cauldron 3 where distortion around rivet holes along the B/C join suggests that the rivets were punched from the exterior to the interior. Additionally, the marking out for rivet placement on the exterior of the bowl of cauldron 19 would suggest that the rivets were punched from the exterior inwards, as working from the interior these markings would not be visible.

The majority of cauldrons have copper alloy rivets along the A/B join fastening the iron and copper alloy sections of the cauldron together, with the exception of cauldrons 3 and 5 and fragment 20 which are joined with iron rivets. While both iron and copper alloy rivets have been found along the A/B join, iron rivets were only used on the iron/copper alloy joins, but never on copper alloy/copper alloy joins, possibly due to differences in expansion rates or the properties of the two metals.

The choice of metal for riveting along the iron/copper alloy join may also have depended on aesthetic rather than technological considerations as both have been found. Iron rivets along the join may have been largely invisible whereas copper alloy rivets would have contrasted with the iron forming a decorative feature (see **Fig. 49**). Additionally, the shape of the riveting may have had a decorative as well as functional role as is seen on other cauldrons, such as the example from Spetisbury (Joy 2014, no. 39). For example, the domed copper alloy rivets along the A/B join would have stood out visually from the darker iron, and reflected more light from the fire than rivets hammered flush. It is uncertain how visible this decorative effect would have been, however, as the cauldron is likely to have become covered in soot through usage. Of the cauldrons with copper alloy rivets along the A/B or A/C join, 11 have domed rivets irrespective of cauldron type, and only those on cauldron 6 are not domed.

The size of rivet heads along the exterior of the A/B join range from 3mm to 6mm while those at the B/C join tend to be the same diameter or smaller. All the rivet heads along the exterior of the B/C join are hammered flush with the surface of the bowl. In fact, there seems to be little correlation between the type, shape and size of the rivets at the A/B join and those of the B/C join on individual cauldrons. This may be due to aesthetic reasons or differences in function, with the rivets of the A/B join visible (domed and copper alloy against iron) and those of the B/C join invisible (flush and copper alloy on copper alloy) rather than, as Gerloff (1986, 87) suggested, conclusive evidence that the copper alloy bowl section is a repair.

The spacing of rivets and their distribution along the joins are very even, indicating that the position of the rivet holes may have been measured or marked out, as with those along the B/C join on cauldron 19. Generally, the only variations in the rivet distribution come where they have been intentionally clustered for structural reasons, for example, either side of a tear in the metal. The distance between rivets along the joins does vary greatly between cauldrons. Along the A/B join the distance between rivets

varies from 14mm on cauldron 4 to 44mm on cauldron 10. The distance between rivets on the B/C join is equal to or less than that on the A/B join and the variation in the range of spacing between cauldrons is much less. For example, the distance between rivets at the B/C join on cauldron 11 is 12mm and on cauldron 10 is 30mm. The average spacing along the B/C join is around 20mm and the closer distribution may be due to technical reasons. At the A/B join the sheet metal sections being joined curve in one direction, whereas the metal at the B/C join curves in two directions and a shorter distance between rivets may have been needed to pull the two sections of copper alloy together and reduce leakage of the cauldron contents.

On two of the substantial fragments, 18 and 21, double rows of riveting are evident. On 18 the double row of offset rivets is along the B/C join. These may have been a decorative feature, but additionally they may have been required for the structural cohesion of the cauldron as it appears to have been very large at an estimated 740mm in diameter. Fragment 21 has a double row of riveting along the scalloped B1/B2 join as part of the decorative scheme. The rivets are positioned in the centre of each scallop and at the apex between scallops (see **Fig. 55**).

Evidence of use, wear and repair

Jody Joy and Alexandra Baldwin

Repair

Repair is defined here as the mitigation of damage incurred during the useful lifetime of the object. The degree of repair to each cauldron may be dependent on many variables: for example, size, techniques of manufacture, age at deposition and frequency of use. Additionally, the dogleg type of cauldron with hollow rim appears to have sustained less damage than is evident on the straight or flaring convex cauldrons, with cauldron 13 having no evidence of repair at all. Whether this is a coincidence, or the form of the dogleg cauldrons is stronger, or this type of cauldron was not as old at the time of deposition than the straight/flaring convex type, is unknown.

The extent of repair to cauldrons varies significantly, with some having minor repairs to the copper alloy and others showing multiple patching and repair to larger components of the vessels. Cauldron 14 is little repaired with patching of only two areas; however, it is the smallest of the cauldrons within the group and would be more stable as the metal has been worked to a lesser degree, and it would have been subject to less stress during its working lifetime as it carried less weight. Cauldron 9 is the largest cauldron and has been patched especially over the very thin copper alloy of band B. Cauldron 15, one of the cauldrons made with a one-part copper alloy bowl, is heavily patched, both on the iron and copper alloy along the A/C join with a large copper alloy repair 18 × 190mm and nine iron patches; it is also heavily patched on the interior of the bowl with eight patches to tears in the metal. The high level of repair is possibly due to the inherent weaknesses of its design (**Fig. 70**).

Also evident are significant losses of important components of many cauldrons which seem to have put the vessels beyond repair and would probably have required



Figure 70 Detail of extensive repair with both copper alloy and iron sheet patches along the A/C join of cauldron 15

high levels of specialist skill to get the vessels back into working condition, for example the loss of a handle or base. This damage is discussed further below.

Repair to copper alloy

Repair is more common on the copper alloy sections of the cauldrons possibly due to the thinness of the copper alloy and its susceptibility to damage. The majority of damage to the copper alloy sections of the cauldrons has been repaired by small individual patches riveted in place; there is no evidence on any of the cauldrons for soldered patch repairs. The form of these patches varies from those which are neatly cut and shaped and carefully riveted in place with small almost invisible rivets, to those which are more rudimentary, with unshaped pieces of sheet that were probably scrap fragments. This disparity between the repairs, sometimes on a single cauldron, may indicate different phases of repair and therefore the different skill levels of those carrying them out. Similarly, Northover and Gerloff (1988) deduced from their study of Bronze Age Atlantic cauldrons that, while manufacture was a specialist skill, judging by the poor workmanship many repairs were likely to have been carried out locally with whatever materials were at hand at the time.

Copper alloy multiphase patching

Multiphase patching is evident on a number of the more heavily repaired cauldrons including cauldrons 4, 5 and 7. The interior of cauldron 4 along band B and the A/B join

has two areas of multiphase patching, one with eight overlapping patches and the other with five (**Fig. 71a–b**). The layers of patches show distinct differences in both the shaping of the sheet metal and in the style of rivets, with a combination of neatly cut metal and fragments of probably scrap sheet metal riveted with different-sized and -shaped rivets. The lower layers seem to be riveted with 6mm rivet heads while a small carefully cut oval patch with neat and nearly invisible 2mm rivet heads displays two distinct phases of patching. The differences between the layers of patches suggest that these were weak areas where the repairs failed and were re-repaired a number of times by workers with different levels of skill.

Exterior patches

Patching is usually carried out to the interior of the vessel, as this would be more effective because the weight and force of the contents would push the patch closer to the sides creating a more watertight repair. However, exterior patching is present on both cauldron 4 and 18. The patching on 18 is present on both the exterior of band B and bowl C. The patch on the exterior of cauldron 4 is rectangular on the exterior of band B and butts up to the B/C join, covering an earlier paperclip repair (see p. 122).

Replacement bowl C

It is possible, as mentioned above, that the bowl sections C of some or all of the cauldrons with two sections of copper alloy

Figure 71a–b Multiphase patching on the interior of band B on cauldron 4

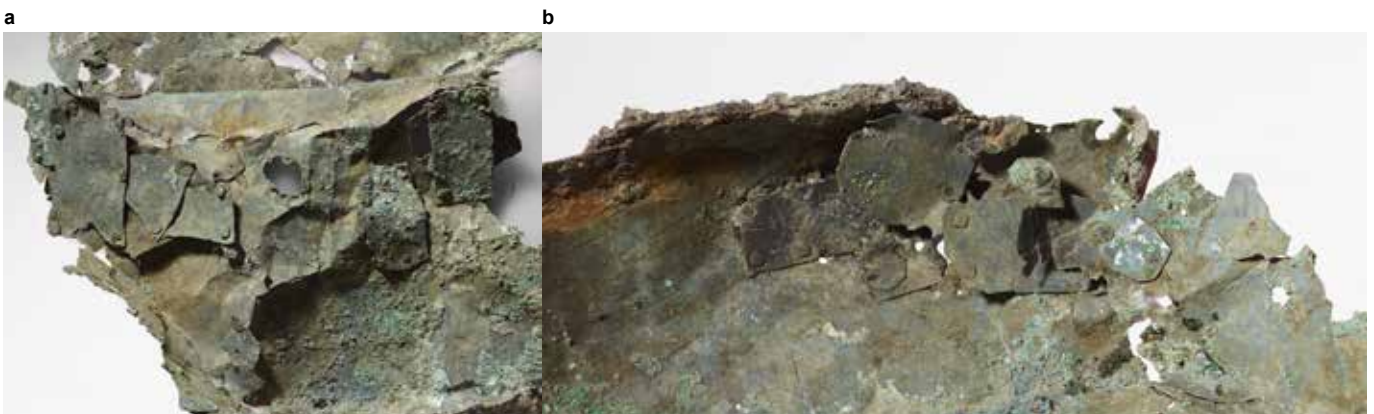




Figure 72 Fragments of cauldron 22 from band B1, B2 and bowl C

(band B and bowl C) are later repairs. With the thinness of the copper alloy and repeated use over a fire the base of the cauldron would be vulnerable to damage. Cut marks along the bottom of band B at the B/C join and marking out (discussed above) are possible evidence that damaged base sections were trimmed away and replaced, and this may not have been done at the time of manufacture but as a result of later damage to the bowl. Gerloff's (1986) study of Bronze Age Class A cauldrons has suggested that many cauldron bowls previously thought to have been attached at the time of manufacture are in fact later repairs, and these repair sections are distinguishable by the roughly cut edge where the damaged section was removed as well as a thicker repair bowl (see also Joy 2014, app. b). That damage to the base of the cauldrons was a frequent occurrence is supported by evidence within the Chiseldon deposit. The condition of some of the cauldrons at the time of burial reveals that five (cauldrons 7, 10, 12, 13 and 14) have been deposited with damaged or missing bases that have not been replaced prior to deposition, perhaps because, as suggested above, no one of sufficient skill was available to execute the repair.

Fragments from vessel 22 represent a series of pieces from bands B1, B2 and C of a cauldron and indicate that cauldron bases could be, and were, repaired in the Iron Age (**Fig. 72**). These fragments were placed in the deposit above cauldron 4 as a separate section of possibly folded copper alloy sheet metal. B1 is very fragmentary and greater than 80mm in width. It is riveted to the interior of a curved strip of copper alloy 24mm wide which forms B2. B2 is fragmentary, but there are no vertical joins visible and it is probable that it was made in one piece. B2 is riveted to the interior of a small bowl C approximately 200mm in diameter. What makes these fragments remarkable is an additional set of redundant rivet holes at the bottom of B1 which suggest that the damaged bowl section was removed along the B/C join and

B2 and C were riveted on as a later addition. It is also possible that B2 and C, rather than being purpose-made to repair the cauldron, were cut as a unit from the base of a second scrap cauldron. Again, this may indicate that the specialist knowledge required for the shaping of metal sheet was scarce or that it was easier and used fewer resources to repair the cauldron using scrap metal from a second damaged cauldron.

Additional evidence from fragment 21 of a second set of rivet heads along B2/C, 4mm at 16mm intervals, not visible on the exterior of the cauldron, suggests that bowl C may have replaced an earlier bowl. The rivets present on the interior of band B2 represent the original riveting for the B/C join, which has been left in place, with the replacement bowl covering those on the exterior of the vessel.

Rivets with washers on copper alloy

Seven of the cauldrons or substantial fragments within the deposit have small copper alloy washers between the rivet and the sheet metal of the cauldron, on some but not all of the rivets. While some of these rivet washers are in association with patches and repairs to the sheet metal others are on rivets either holding sections of the cauldron together or at the base of stress fractures. Some are clearly related to the construction phase of the cauldron and others relate to incidences of repair.

Cauldron 4 has one visible square washer to a fatigue crack on the exterior of C at the B/C join. The square rivet which holds the rivet washer in place is identical in size and shape to other rivets along the B/C join. Both the repair to the stress fracture and the similarity between the rivets indicates that the rivet washer is contemporary with the addition of bowl C, and possibly with the manufacture of the cauldron.

Cauldrons 12 and 15, both cauldrons with only A and C sections, have rivet washers along the A/C join. Cauldron 12 has an iron rivet and a washer 13mm in diameter on the interior along the A/C join on the copper alloy of the bowl but through both the iron of band A and the copper alloy of bowl C. Cauldron 15 has both iron and copper alloy rivet washers along the exterior of the A/C join. The complex fragments of bands B1 and B2 of cauldron 22 have square copper alloy rivet washers on both the interior and the exterior along the line of the functional rivets at the B1/B2 join and the B/C join.

On cauldrons 5, 7, 9 and 10 the rivet washers occur in relation to fancy patches. On cauldron 7 one of the rivets securing the comma-shaped scalloped patch has a rivet washer on the exterior, and cauldron 10 has an iron rivet washer in association with a fancy patch on both the interior and exterior rivet head. Cauldron 5 has circular, square and triangular rivet washers both internally and externally in association with scalloped patches (**Fig. 73**). The rivet washers have sharply cut edges.

Cauldron 7 has both square and round rivet washers present on both the interior and exterior in association with a tongue-shaped patch; eight square and triangular rivet washers on the interior and exterior are associated with the lowest layer of multiphase patching; two rivet washers in association with a triangular patch across the B/C join on

the interior; and both square and triangular rivet washers on the interior of band B along the B/C join. The association of the rivet washers on this cauldron with patching and the B/C join may indicate that it was carried out at the time of manufacture and may date some of the repairs to this point in time.

Paperclip repairs

Paperclip repairs are small repairs to either the copper alloy of band B or the bowl made from a thin strip of copper alloy folded with both ends inserted into a slit in the cauldron from the interior with the flaps folded back against the metal of the exterior and the internal fold hammered down to resemble a paper fastener (**Fig. 74**). This type of paperclip repair is fairly common and has been documented on Iron Age cauldrons of all types from Groups I to IV (Joy 2014, app. b). Paperclip repairs are present on vessels 4, 20, 8 and 11 within the Chiseldon group. On cauldrons 4 and 20 they are covered over by later riveted patches, suggesting that they were done during an early phase of repair.

Additional riveting along joins

Additional riveting to the B/C join is present on cauldrons 5 and 7. Along the north section of the B/C join of cauldron 5 the rivet spacing changes from 17–24mm to 6–10mm, indicating possible additional inter-dispersed riveting to hold a loosening or damaged join. On vessel 7 secondary riveting of a different size is present on the B/C join with the original rivets 4–5mm on the interior of the cauldron and 3mm on the exterior and the additional rivets 2mm both on the interior and exterior.

Patching to the iron

While, in the majority of cases, it is the thinner and softer copper alloy that has more patching due to its susceptibility to damage, there are also cauldrons with substantial repairs to the iron banding and rim of the cauldrons. Due to the condition of the iron sheet and the highly corroded surface, any evidence of repair or riveting is much harder to see than on the copper alloy and therefore many repairs on the iron may have been overlooked.

Repairs to iron are less varied than those on the copper alloy sections. The most common type consists of riveted patches to the interior of band A, as well as occasional reinforcements to the rim, for example on cauldron 4 where the rim is reinforced with an iron strip 38mm wide folded over the rim and extending onto band A on both the interior and exterior next to the southwest handle.

The multiple patching to the iron band both internally and externally on cauldron 3 and reinforcements to the iron, especially in the area of the handles, as well as the possible replacement rim, suggest either heavy usage or a badly made cauldron to which structural reinforcements had to be made. The heavy patching and replacement rim are at odds with the copper alloy of band B and bowl C, which apart from patching to stress fractures is in good condition with no visible repairs.

Cauldron 14, the smallest of the cauldrons present in the Chiseldon group, has an iron repair backing sheet in the area of the handle stop left of the east handle. Damage to the

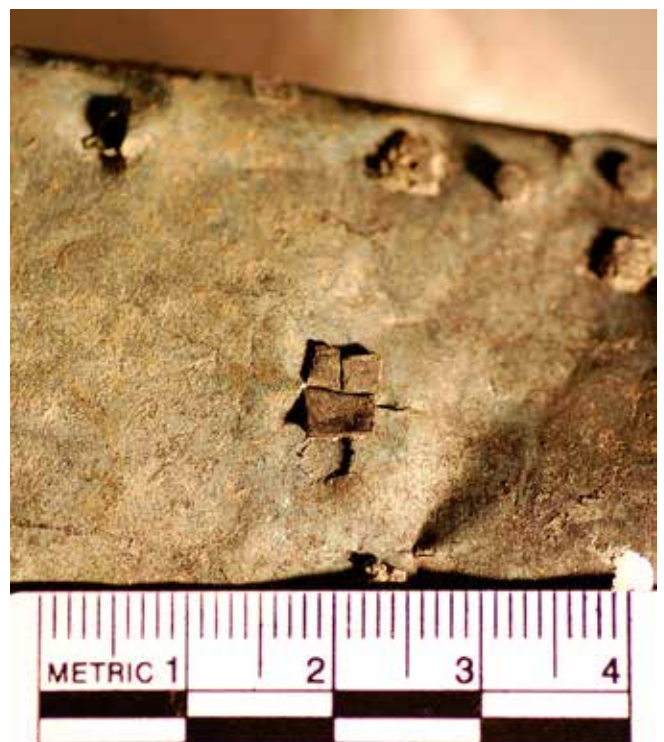


Figure 73 Circular, square and triangular rivet washers on a scalloped patch riveted to the interior of a fragment from cauldron 5

area includes loss of the handle stop and substantial damage to band A, which has been repaired with three iron patches riveted to the interior of dimensions 35 × 30mm, 85 × 25mm and 85 × 20mm.

Although in most instances copper alloy sheet has been used to repair copper sections of the cauldrons and iron sheet to repair the rim and band A, there are instances where this is not the case. A copper alloy patch over a possible repair to the iron on band A is present on the north side of cauldron 2 measuring >70 × 30mm. The repair to the interior of band A is in copper alloy but the rivets used are iron, making the repair invisible from the exterior of the cauldron. Cauldron 10 is reinforced at the A/B join with a large iron patch which covers the join and is riveted to both

Figure 74 Paperclip repair on the exterior of cauldron fragment 20



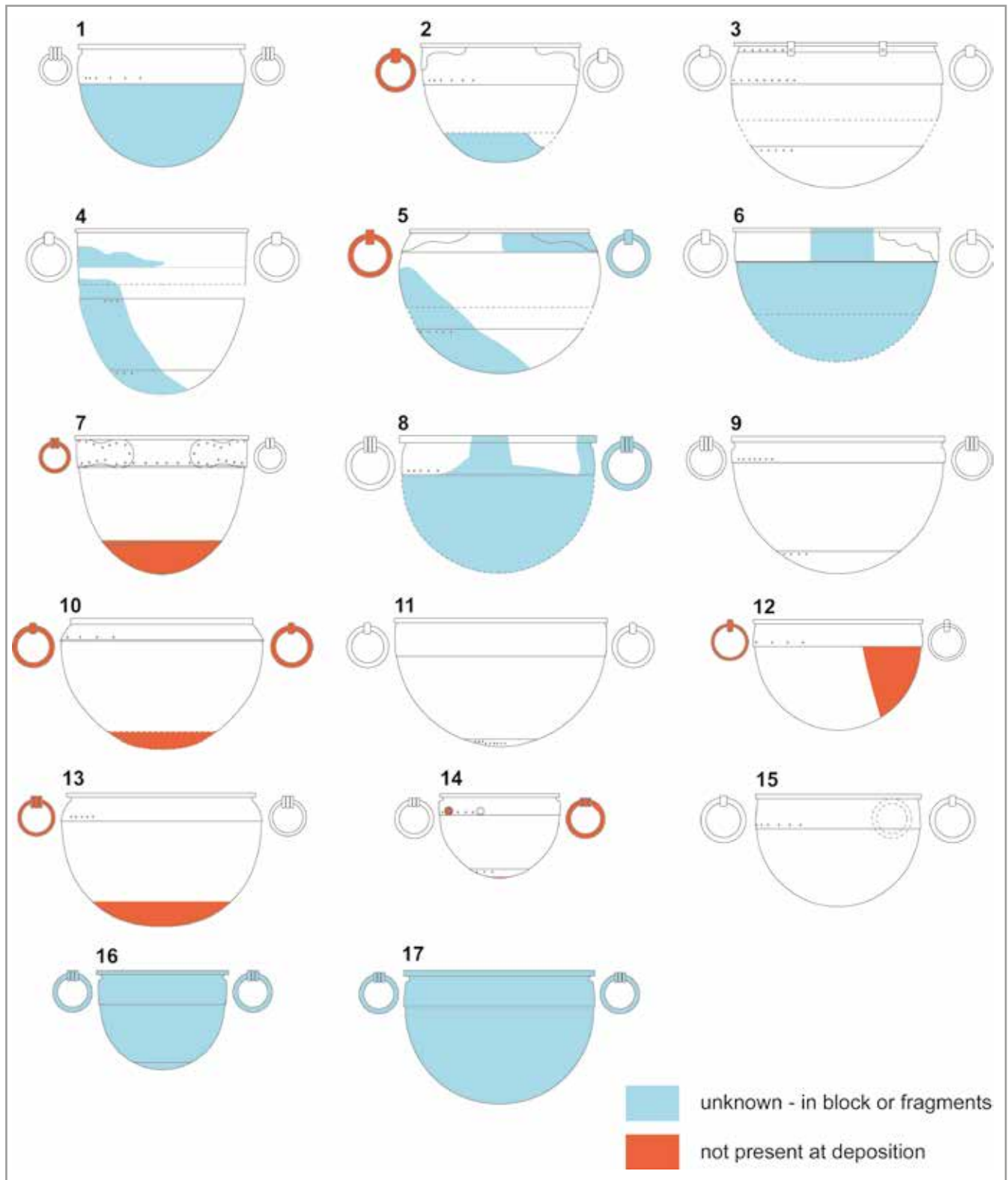


Figure 75 Schematic drawing of damage to cauldrons on deposition

the iron and copper alloy. Additionally, a large iron plate 310 × 50mm is curved along the B/C join on the east side of cauldron 3. The purpose of this large iron plate over the join is unknown, and no damage to the underlying copper alloy is visible, although it may have acted as reinforcement to the B/C join and corrected a weakness or flaw in the riveting. With the presence of a large number of iron repairs on band A it is tempting to speculate that this iron repair over the copper alloy at B/C was made at the same time and iron was the only material they had at hand.

Condition of the cauldrons at burial **Alexandra Baldwin and Jody Joy**

Cauldrons

A number of the cauldrons and cauldron fragments display evidence of damage prior to deposition. We classify damage as major loss of a section or part of the cauldron putting the object beyond repair by a non-specialist. Some of this damage may have occurred as part of the activities associated with the incorporation and deposition of the



Figure 76 Cauldron fragment 18: a large section of band B and bowl C cut from a cauldron and deposited in the pit as a fragment

cauldrons in the pit. Other damage could be as a result of wear and tear from use that had not been repaired prior to deposition. The exact state of a number of the cauldrons on deposition is hard to determine. With the weight of the overlying soil crushing their form and the highly fragmentary nature of the metal sheet, conservation has played a large part in identifying their condition at the time of deposition rather than that incurred during burial and excavation.

Of the 17 cauldrons within the Chiseldon deposit, six (cauldrons 2, 5, 7, 12, 13 and 14) are missing handles and handle mounts; one (cauldron 10) is missing both handles; while five cauldrons (7, 10, 12, 13 and 14) have additional substantial damage to the copper alloy section with cauldrons 7, 10 and 13 all missing bases or bowls. Three (cauldrons 3, 9, 15 and possibly 11) had no major damage and appear to have been in working order at the time of deposition. It is not possible to be certain of the condition of five of the cauldrons owing to their position in the pit (located close to the original exploratory hole excavated by the metal detector user) and four remain partially or completely unexcavated within two remaining soil blocks (**Fig. 75**).

Fragments

In addition to whole cauldrons, large fragments were also placed into the deposit including 18, 19, 20, 21 and 22. In some instances it is hard to be certain of the exact number and nature of the fragments within the pit due to the disturbance caused by the finder, but there is evidence that large parts of cauldrons were deliberately deposited as fragments. The distribution of these indicates that they were placed in the top layer of the deposit after the whole cauldrons were placed in the pit. Fragment 18 was found over vessel 7 in the north of the pit, 20 and 21 were from between cauldrons 1 and 4, and both of the base sections 19 and 22 were in the centre of the pit above cauldron 4 (see **Fig. 16**).

Fragment 18 is a triangular-shaped section cut from the copper alloy band B and bowl C of a cauldron and represents between a quarter to a third of the original vessel (**Fig. 76**). The edges where the fragment has been removed

have been cut and then hammered, producing a slightly wavy edge. The cut and hammered edges indicates that special care was taken to remove this section and suggests that perhaps this fragment was significant and curated in the period before deposition.

The well-preserved copper alloy bowl C from cauldron 19 was placed in the ground as a fragment detached along band B close to the B/C join. Fragment 22 was disturbed by the original excavation but appears to have come from above cauldron 4 and is the base of a vessel including band B1, B2 and C although the full extent of the fragments is unknown. The lines of detachment of both bowl fragments have rough edges so the fragments were not cut away from the cauldron but probably pulled or torn off. While the curvature, depth and size of fragment 19 are inconsistent with any of the missing cauldron bases there is a possibility that the smaller-sized fragment 22 may be from the bottom of one of the damaged cauldrons present in the deposit.

Fragments 20 and 21 are from the same area of the pit and appear to have been buried as fragments. Their relationship to each other is unclear; although comparison between the results of the metal analysis for the two fragments is inconclusive they do share certain physical characteristics which suggest that they may have been from the same sheet before being bisected by the finder's trench. Both sections of copper alloy sheet retain evidence from the A/B join and both have the remains of iron rivets with a similar spacing and size (**Table 4**). With the lack of evidence for copper alloy from cauldron 1 present in the pit it was initially assumed that these fragments related to the iron rim and

Table 4 Comparison of measurements of cauldron fragments 20 and 21

	Cauldron fragment 20	Cauldron fragment 21
A/B overlap	14mm	10mm
Rivet holes punched		INT to EXT
Rivet spacing A/B	25–9mm	26mm
Rivets	Iron	Iron
Rivet size	4mm	4mm
Depth of band B1	>160	230



Figure 77 Tri-ribbed handle attachment and fragment of rim and band A from cauldron 8

band of this vessel; however, the rivets along the A/B join on cauldron 1 are copper alloy and spaced at 39mm. Other cauldrons in the vicinity of the two fragments 20 and 21, including cauldron 4 and 7, bear no similar features to these fragments indicating that they were not part of one of the complete cauldrons.

While care has been taken to process the edges of fragment 18, the handling of the other fragments prior to burial is quite varied, which perhaps provides evidence for a number of different practices. For example, the edges of the bowl fragment 19 are rough and therefore were not cut, and fragment 22 was possibly folded and incomplete when it was deposited. Also it may not be coincidence that fragment 21, from a uniquely decorated cauldron with scalloping on the lower edge of band B1, and fragment 18 with decorative patches along the A/B join, were deposited as fragments.

Decoration

Jody Joy

A number of different forms of decoration have been noted on the cauldrons and cauldron fragments. In the main, this is in the form of small decorative copper alloy patches or repairs as well as scalloped edging carefully cut using metal shears (see **Fig. 57a–b** for the range of decoration seen on cauldrons). More unusually, four of the cauldrons (2, 5, 6 and 7) have decorated iron plates, all located just under the rim in the vicinity of the handles.

Decorative copper alloy patches/repairs

Twenty-five decorative copper alloy patches from 8 complete cauldrons, as well as 11 from 7 cauldron fragments, have been found. The term ‘decorative’ is used here where patches/repairs of unusual form are observed, where more work has been done than is necessary for ‘functional utility’ (see Megaw and Megaw 2001, 19).

In addition to exterior patches, many decorative patches occur on the inside of cauldrons and so would not have been visible when they were being used. Most of these were made at the time of manufacture. The process of forming sheet copper alloy by sinking (see ‘Techniques of manufacture’ section above) creates v-shaped tears at the edges of the metal as it is stretched. To maximise the size of bowls, rather

than trimming the edges down to remove them, the tears have been patched. Special care seems to have been taken over these patches, perhaps an attempt by metalworkers to make up for the defects created during sinking and raising. An example of this kind of patch can be seen on the inside of fragment 18 near the top of the bowl (see **Fig. 57a–b**). It comprises a narrow sinuous strip of copper alloy that has been carefully cut to shape using shears and is secured by at least four rivets. Another example is a triangular-shaped patch (again on fragment 18). It has scalloped edges that have been carefully marked out, cut with shears and filed (see **Fig. 68a–b**).

Cauldrons 1, 8, 9, 13, 16, 17 and 14: tri-ribbed handles

At least seven of the cauldrons have tri-ribbed handle attachments (**Fig. 77**). This is a feature seen on other Joy type II cauldrons including the example from Baldock (Stead and Rigby 1986, 55, fig. 23; Joy 2014, app. b). It is also possible that it could be a reference to the ribbed handle-straps of bronze on cauldrons from the Earliest Iron Age. The tri-ribbed handle attachment is probably primarily functional (providing a secure fixture between the handle and the band) but nevertheless stands in stark contrast to the often otherwise plain cauldrons.

Fragment 21: scalloped edging to cauldron bands

The outside edge of the join between bands B1 and B2 of the cauldron fragment 21 has been scalloped (see **Fig. 55**). Examination of patches with similar scalloped edging under a microscope has revealed crimping of the metal that is characteristic of the use of shears. The scallops on fragment 21 are on average 14mm wide and 7mm deep. This type of decoration is not seen on any other cauldron from Britain or Ireland (see Joy 2014, app. b) and like the decoration described below, it is unique to the Chiseldon assemblage.

Decorative iron plates

Cauldron 2: Cattle head decorative mount.

Cauldron 5: Early and Vegetal Style decorative mount.

Cauldron 6: Vegetal Style decorative mount.

Cauldron 7: Curved iron mounts.

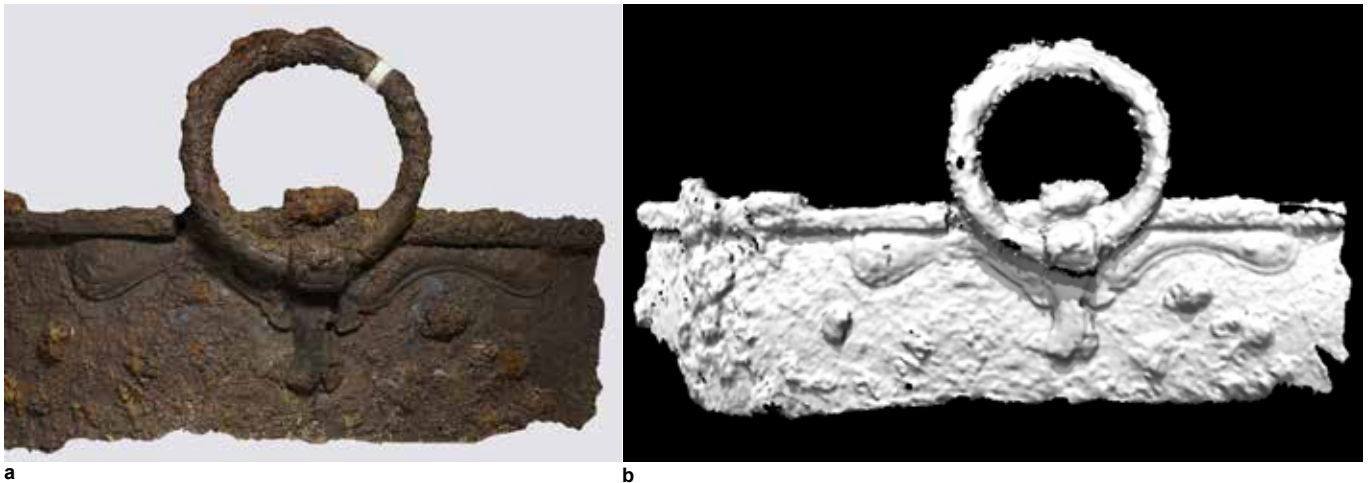


Figure 78a–b Decorative handle plate in the form of a cattle head at the northeast handle of cauldron 2: a) photograph; b) laser scan

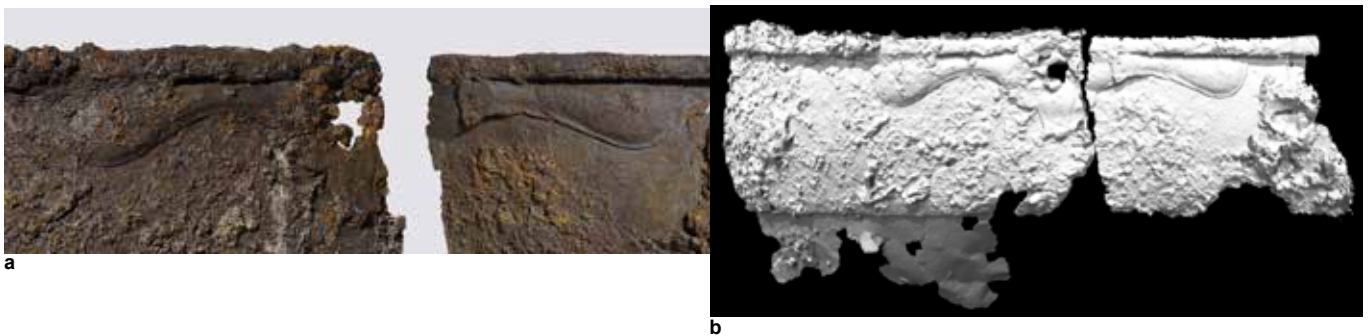


Figure 79a–b Decorative handle plate in the form of a cattle head at the southwest handle of cauldron 2: a) photograph; b) laser scan

Cauldron 2: Cattle head decorative mount (Figs 78a–b and 79a–b)

125mm across by 55mm high. The plate is in the form of a cow or bull's head with elongated horns or ears. The features are delineated in raised decoration. It has lentoid-shaped eyes, a long snout and flaring nostrils. The plate is located directly below the rim and is centred at the location of handle attachment.

Below the handle attachments of cauldron 2 are two iron plates in the form of a cow or bull's head with elongated horns or ears (**Fig. 78a–b**). The outline of the cattle head and its features are difficult to make out due to the state of preservation of the iron, but it appears to have lentoid-shaped eyes and flaring nostrils. The two elongated fin-shaped sections of the mount located on either side of the top of the animal's head could represent either ears or horns. Iron Age cattle were of the short-horned variety (see Higbee, Chapter 7) and the majority of the bovine-form mounts and escutcheons dating to the Late Iron Age or Early Roman period (see below) also have relatively short horns, but there are some examples with longer horns (see Jope 2000, pls 166, 172–3). The handle attachment is located directly above the cattle head. When in use, the cauldron handles would have been positioned upwards. The handle could, therefore, also be interpreted as representing the animal's horns, animating the object. This argument is supported by a computer-generated reconstruction of cauldron 2 that is illuminated from the bottom, as the cauldron would have been by the fire when it was in use (**Fig. 80**). In this reconstruction the necessity for raised decoration is underlined as the raised features – nostrils,

ears/horns and the 'horns'/handle – are picked out by the flickering firelight.

In Europe, stylised but recognisable versions of animals are seen in Early Style and Sword/Plastic Style art and in the Late Iron Age on objects such as buckets (Jacobsthal 1944 [1969]; Hunter and Joy 2015, 72). In Britain, there are also possible faces in the decoration on the Wandsworth shield boss and the Witham shield, but images of animals are otherwise largely absent until the 1st century BC (Stead 1996, 56), when bovine forms are seen on vessel mounts, escutcheons and firedogs. Many of these 1st-century objects decorated with bovine forms have a wider distribution and they are also found in Switzerland, southwest Germany, northeast France and southeast England (Feugère 2002). Stylistically, though, the mount appears most like the 1st-century AD horse mask from the Stanwick hoard (**Fig. 81**) (which is itself a unique object) than these bovine forms. Therefore, despite the early deposition date of the Chiseldon hoard to the 4th or 3rd centuries BC (Chapter 11), the decoration on cauldron 2 most closely matches art styles most commonly dating from the 2nd century BC to the 1st century AD.

No other British cauldron is adorned with zoomorphic decoration and examples with any form of decoration are rarely found. Two cauldrons from Kincardine Moss and Ballyedmond are decorated with geometric patterns and ring-and-dot motifs but these are earlier than the Chiseldon cauldrons and probably date to Hallstatt D (Joy 2014, 11). On the Continent, decorated cauldrons are also uncommon. A few notable Early Iron Age examples originate from the



Figure 80 Reconstruction of cauldron 2 showing the decoration illuminated from below by flickering firelight

Mediterranean, including the Greek cauldron from Hochdorf, southwest Germany, decorated with lions (Biel *et al.* 1985).

Kaul's (2007, 333–40) survey of richly decorated cauldrons from Denmark includes many objects thought to have been imported from elsewhere. He identified the well-known Gundestrup cauldron as being of Thracian manufacture, style and technique, but with 'Hellenistic traits' and depicting 'Celtic objects' such as helmets and torcs. In contrast, he thought the cauldron from Mosbaek, depicting masks of a beardless Herakles, was of Etruscan manufacture. The cauldron from Langå is intriguing. Identified by Kaul as 'Etruscan work' and made about 475–450 BC, it was found in a 1st-century BC grave and was therefore in circulation for up to 400 years (Kaul 2007, 335). The 3rd-century BC cauldron from Brå (Mortensen 1991, 375) is decorated with animal heads and the bronze attachments of each of the three handles are each decorated with an owl's head. There are also six bulls' heads that acted as 'stops', preventing the handles from damaging the cauldron bowl. Kaul (2007, 335) believed the Brå cauldron was probably manufactured at Manching in southwest Germany sometime around 300 BC. Two final cauldrons from Sophienholm and Rynkeby are both decorated with human and animal figures and are thought to originate respectively from Central Europe and France (Kaul 2007, 336).



Figure 81 Stanwick horse mask, 50 BC–AD 100. British Museum, 1847,0208.82

Kaul's survey demonstrates the wide distribution of cauldrons originating from the Mediterranean, some of which were in circulation for a very long time. It also highlights the manufacture of decorated cauldrons in other parts of Europe, indicating that although probably quite rare, decorated cauldrons of various forms and different origins may have been in broad circulation throughout much of the Iron Age.

In summary, the mount shares similarities with objects made in the Late Iron Age but it is a unique object. Given the dating of the deposition of the Chiseldon hoard to the Middle Iron Age, it is possible that cattle art was a much longer-lived tradition in the British Isles than previously thought, but the decoration on cauldron 2 could equally likely be a one-off, perhaps with Continental parallels. As such, it probably cannot be allocated to any one single style or stage of art. The potential issues associated with this conclusion will be further discussed in Chapter 12.

Cauldron 5: Early and Vegetal Style decoration (Fig. 82a–b)

320mm across by 50mm high. The plate is unfortunately only one half of the handle plate broken at the area of the missing handle mount (the rest is unexcavated in a block). It comprises raised decoration in both the 'Early' and 'Vegetal' or 'Waldalgesheim' Styles and sits just under the rim to one side of the location of the (missing) handle. This pattern would have presumably originally been mirrored on the opposite side of

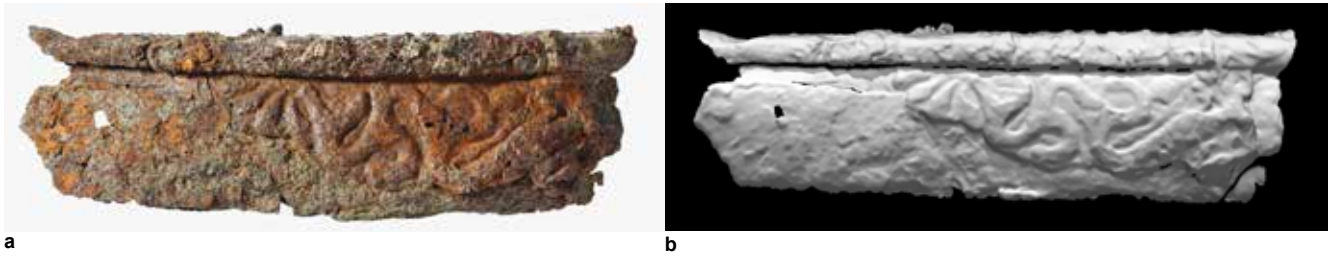


Figure 82a–b Early and Waldalgesheim Style decorated handle plate from cauldron 5: a) photograph; b) laser scan

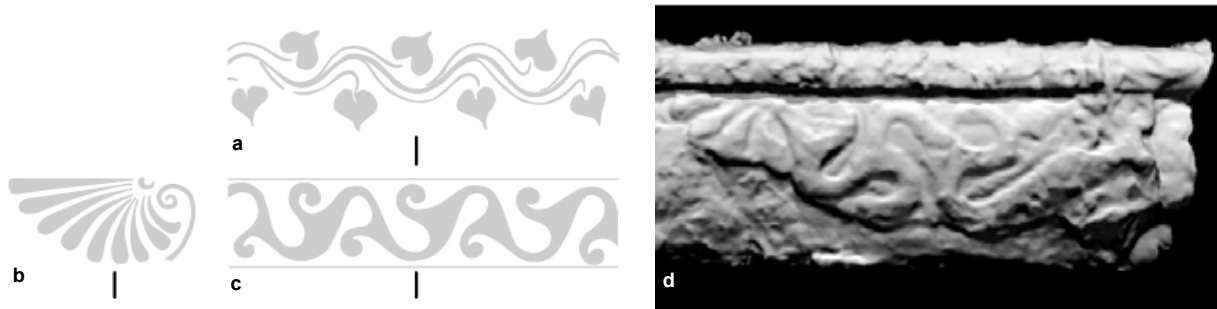


Figure 83a–d Diagram of stylistic influences of decoration on the handle plate of cauldron 5

the cauldron. From left to right, the decoration comprises a simple half-palmette that links to a serpentine scroll with at least three curvilinear tendrils (**Fig. 82a–b**).

The design encompasses two art styles first identified by Jacobsthal (1944 [1969]), the ‘Early’ and the ‘Vegetal’ (or ‘Waldalgesheim’) Styles (e.g. Verger 1987; Megaw and Megaw 2001, ch. 3). The Early Style, as its label suggests, is the earliest form of so-called Celtic art dating from as early as the 5th century BC and is seen to be partly borrowed and adapted from Greek and Etruscan motifs such as palmettes and lotus flowers (Harding 2007, 42; for a concise summary see Joy 2015b). Rare examples of objects adorned with Early Style ornament from Britain include the palmette and lotus petals on the headdress from Cerrigydrudion, Conwy, the sword handle from Fiskerton, Lincolnshire, and the sword scabbard from Wisbech, Cambridgeshire, decorated by a palmette flanked by lotus petals or lyres (Stead 1996, 20–4). The decorated plate of cauldron 5 includes a very simple half-palmette with four ‘fronds’. By using half a palmette (**Fig. 83a**) this symmetrical motif has been linked to the sinuous asymmetry of the Vegetal Style decoration that ornaments the remainder of the plate (**Fig. 83d**).

The Vegetal Style dates to the 4th century BC and is widely distributed from eastern Central Europe to Britain

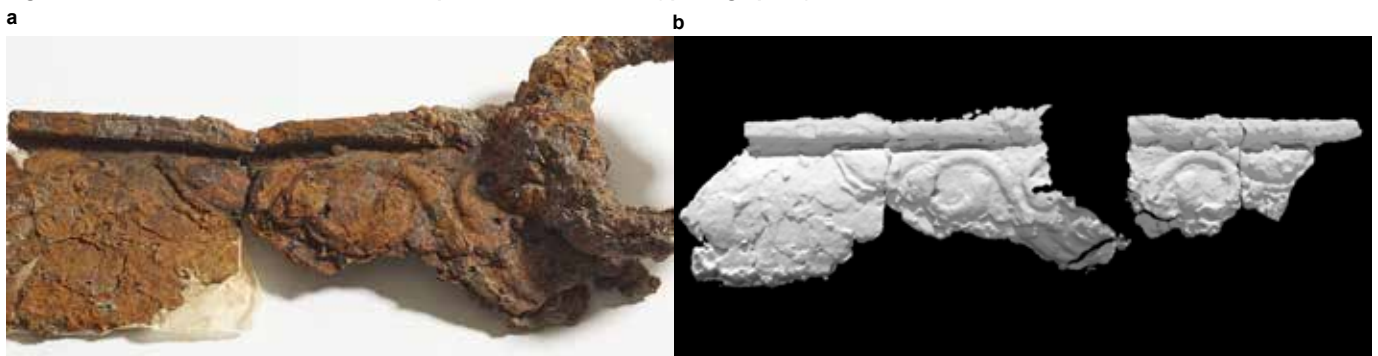
(Jacobsthal 1944 [1969]; Frey 1976; Verger 1987; Frey in Joachim 1995; Megaw and Megaw 1995; Stead 1996, 22; Harding 2007, 70–6). The style was first identified by Jacobsthal (1944 [1969]) who named it after the well-known burial from the Rhineland (see Joachim 1995), although subsequent finds revealed that this grave is at the edge of the main distribution of finds. Rare examples from Britain include decoration on a bronze bracelet from a grave at Newnham Croft, Cambridgeshire, and the decoration on the so-called horn-cap from Brentford, Greater London (Stead 1996, 22–5). Felix Müller (2009, 105–7, figs 123–4) demonstrated very clearly the antecedents from Greek art for the sinuous wave-tendrils of the Waldalgesheim Style (see **Fig. 83b–c**).

In summary, although it incorporates elements of Jacobsthal’s Early Style, the plate can be assigned to the so-called Vegetal Style.

Cauldron 6: Vegetal Style decorative mount (**Fig. 84a–b**)

300mm across by 79mm wide. Comprising raised lobe-shaped decorative motifs. The plate is in poor condition making it difficult to determine the full extent of the design. The overall composition appears to be arranged as a symmetrical scroll with a mushroom pelta. The extreme left-hand arm of the lyre is formed of a lobe with a crescentic-

Figure 84a–b Lobed decoration on the handle plate from cauldron 6: a) photograph; b) laser scan



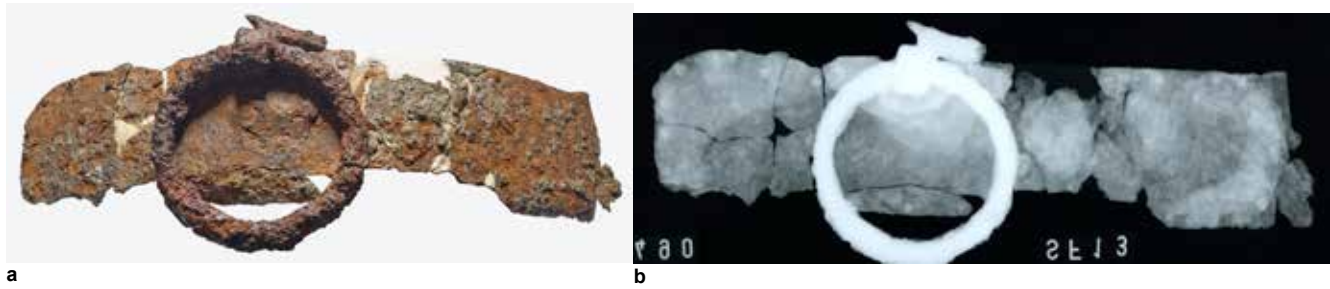


Figure 85a–b Handle plate from cauldron 7 with curved ends and decorative rivets: a) photograph; b) radiograph

shaped tendril extending underneath. Presumably this pattern was mirrored on the right hand side. Extensive damage to the centre of the plate makes it hard to make out the pattern but it appears to form a second lyre.

Much of the design is obscured due to extensive damage and corrosion, making it difficult to attribute it to a style. The crescent-shaped tendril appears to echo elements of the tendrils of the Vegetal Style and the closest parallels of the overall pattern can be found on torcs and armrings from the Marne region of France decorated with simple curvilinear motifs in relief (Harding 2007, 77 and fig. 4.7). Frey (1976, fig. 5c) also illustrated a decorative plate from Brunn am Steinfeld, Austria, which shares a similar overall decorative composition, albeit slightly more complicated. Frey viewed similar designs, particularly from the Marne region, as having close links with the Early Style and saw them as early prototypes of the ‘Celtic fan’, one of the most characteristic motifs of the Vegetal Style (Frey 1976, 148, fig. 5). Stead (1985a, 18) also argued that the Vegetal Style flows from the Early Style without any sharp break.

The central section is harder to make out. It possibly shares affinities with some Early Style art, such as the palmette flanked by lotus petals in the design on the Cerrigydrudion headress and the handle of the Fiskerton sword (Stead 1996, figs 21 and 22a). But it is most similar to a

‘lyre’ pattern identified by Fox (1958, fig. 82, no. 10) and seen on the design of the so-called ‘horn-cap’ from Brentford (Stead 1996, fig. 25). It also shares similarities with the raised motif positioned at the top of the Standlake, Oxfordshire sword scabbard, which has a plate at the bottom with raised decoration in the Vegetal Style (Jope 2000, pl. 48).

Tentatively therefore, the design on this plate is assigned to the Vegetal Style.

Cauldron 7: Curved iron mounts (Fig. 85a–b)

Curved iron plate, which extends 190mm and 150mm either side of the handle mount.

The iron plate is not decorated in relief like those on cauldrons 2, 5 and 6 but rather has raised rivets and is of an unusual construction with the iron band made from four pieces and the handle sections riveted on the outside of the central connecting plates. The sections that the handles are mounted on have curved ends and possible scalloping down the length of the plate edges, but the most distinctive features are the domed rivets which follow the form of the scalloping down the length of the plate and its curved terminals. Surviving fragments from the other handle plate suggest a similar form of decoration on the other side of the cauldron, indicating that this is an intentional decorative feature and not a one-off repair or adaptation.

Chapter 7

Finds Other than the Cauldrons

Lorrain Higbee, Lorraine Mephram and Chris Stevens

All finds and the Wessex Archaeology archive are held in the Department of Britain, Europe and Prehistory at the British Museum.

The cattle skulls *Lorrain Higbee*

Introduction

Two cattle skulls and a small quantity of disarticulated bone fragments were found in the pit. The skulls were on the south side of the pit while the disarticulated bones were recovered throughout the pit fill, and from the residues of sieved bulk soil samples. The assemblage is quantified by species and recovery method in **Table 5** and the biometric data are retained in the archive. No attempt was made to quantify the large number of small, unidentifiable bone splinters recovered from sieved soil samples.

Preservation and condition

The preservation of the bone is extremely good, as indicated by the clarity of fine knife cuts observed on the cattle skulls. However, with the exception of the two cattle skulls, the disarticulated bones recovered from the pit are heavily fragmented and this has inevitably prohibited identification to species and skeletal element. The fragmentation state suggests that the bones were extensively utilised but since there are no gnawed bone fragments, they were probably buried fairly rapidly.

A significant number of the small bone splinters are scorched, burnt and calcined from direct contact with fire, most probably during cooking over an open fire, or from being thrown back into the fire once the meat had been consumed. A number of fragments are also stained green from contact with the cauldrons.

Disarticulated material

The assemblage includes skeletal elements from cattle, sheep, pig, horse and dog. In addition to these important domestic species, a few bones from rodents, amphibians and small birds were also identified; however, all are non-anthropogenic in origin, and merely part of the general environmental background to the site.

Table 5 The assemblage quantified by species and recovery method

Species	Recovered by hand	Recovered from samples	Total
cattle	7	1	8
sheep	15	8	23
pig	4	6	10
horse	3		3
dog	8	2	10
water vole	1		1
rodent		1	1
small bird		1	1
frog/toad	1		1
large mammal	8	1	9
medium mammal	17	16	33
Total	64	36	100

The cattle skulls (SF55 and 117)

The two cattle skulls were both deposited in the southern part of the pit. Both are from a small-horned breed of cattle, and the oval shape of the horn core base suggests that both are from bulls. The parts of the skull represented include the frontal, parietal and occipital portions, while the maxilla, premaxilla and zygomatic are entirely absent and are not even present among the disarticulated bone fragments. Indeed, only one loose upper tooth was recovered from the entire pit. The absence of these elements suggests that the skulls may have been stored or displayed elsewhere prior to deposition. Evidence for cattle skulls being displayed before their deposition has been noted at a number of Iron Age sites in the region, including, for example, Battlesbury and Chemring near High Post, both in Wiltshire (Hambleton and Maltby 2008, 91–2; Higbee in Powell 2011, 77).

The series of faint cut marks visible on both skulls results from skinning. They are evident on the parietal and frontal bones, and most of the cuts are located on the medial part of the parietals between the base of the horn core and the orbit. Further cuts were noted on the left orbit and on the right occipital condyle. The latter probably occurred when the skull was detached from the atlas vertebra.

Summary

The two cattle skulls are well preserved and from a small-horned breed. They were probably deposited after being displayed for a short period, during which the maxillae fragmented and the upper teeth were lost.

The pottery

Lorraine Mephram

Some 54 sherds weighing 563g were recovered in the excavation. With the exception of four Romano-British sherds from the topsoil (100) (two coarse greywares and two

Oxfordshire colour coated wares), all are of Iron Age date.

The fabrics are mainly sandy, in varying degrees of coarseness, some containing rare flint, shell or rock (possibly greensand) inclusions; there are also a few sherds in shelly, shelly/oolitic and flint-tempered fabrics. There are only two diagnostic pieces, both rim sherds. One of these is too small to assign to vessel form (context 101), and the other is from a convex jar from the soil beneath cauldron 9 (context 153). There are also a couple of shoulder sherds from context 101. Three sherds are burnished externally.

The range of fabrics, and the limited amount of diagnostic material, indicates a date range within the Middle Iron Age, broadly the 4th century BC, equivalent to ceramic phases 4–5 at Danebury (Cunliffe 1984a, fig. 6.18; 1995, 17–18, 246–8).

Charred plant remains

Chris Stevens

Individual soil samples were taken next to cauldrons primarily for finds recovery. As a result, they were very small, mostly less than 10 litres in size. The samples were processed using standard flotation with the flots retained on a 500 µm mesh.

The relatively small density of remains meant that they were not suitable for detailed analysis; however, six of them did contain some spelt grains, barley and spelt chaff (glume bases), as well as roundwood charcoal (see Chapter 10). The cereals, in particular the dominance of spelt wheat, are indicative of later prehistoric or Romano-British settlement. As the amount of barley in Iron Age samples from the Thames Valley tends to decline into the Roman period (Robinson and Wilson 1987), the relative quantity of barley in the sample would be consistent with a date in the Early–Middle Iron Age.

Chapter 8

Metal Analysis

Quanyu Wang

The Chiseldon cauldrons, as a large group of near-complete vessels from a single context, provide a unique opportunity to research the manufacture of Iron Age sheet metal objects in detail. Comparative studies of the composition and microstructure of the metal were carried out, within limitations of the state of the corroded artefacts, in an attempt to answer the following research questions:

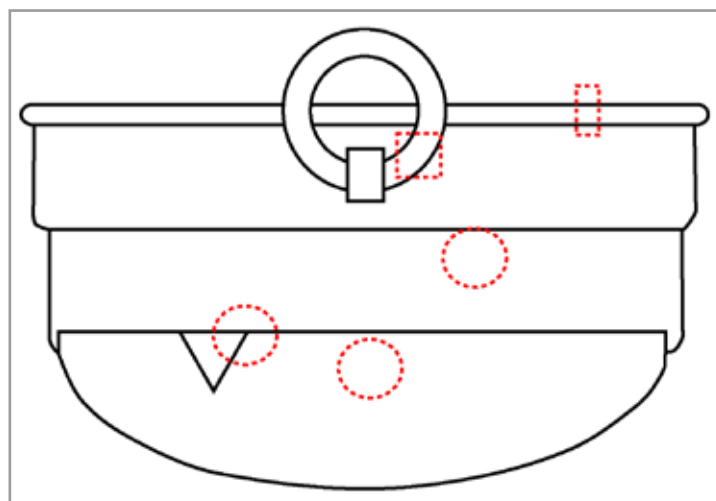
- How were the cauldrons made?
- Were the components of an individual vessel made from the same metal stock?
- Were similar parts from different vessels, and cauldrons of a similar type, made in the same workshop?
- Were the repair patches applied during manufacture or added later?

Sampling

Finding appropriate sample areas for metallurgical study was difficult, as the metal, particularly the iron, was highly corroded and very fragile. The sampling process was made additionally complex by the need to sample an area of potential interest and provide the maximum information on manufacturing techniques without endangering the structural integrity of the objects or destroying any diagnostic features. Areas to be sampled were chosen in consultation with the curator and conservators and recorded in annotated photographs (**Fig. 86**). Fragile areas were consolidated with 3–5% Paraloid B72 in acetone before cutting. Samples were taken with a diamond-coated cutting disc mounted in a handheld proxon Micromot Drill system with industrial methylated spirits (IMS) applied as a coolant.

In total 35 metallurgical samples, 16 iron and 19 copper alloy, were obtained (**Table 6**). The iron samples were taken from the rims, upper iron bands (A₁) and handles of five cauldrons (1, 2, 3, 4 and 8) and from the lower iron band (A₂) of cauldron 4. The copper alloy samples were taken from the bands (B) of four cauldrons (2, 3, 4 and 8) and three significant fragments (18, 19 and 20), and the upper (B₁) and lower band (B₂) of fragment 21, and from the bowl section (C) of cauldrons 3 and 4, and fragments 18 and 19. Additionally samples were obtained from four patches, one rivet and one paperclip repair.

Figure 86 Schematic diagram illustrating areas sampled of cauldron 3 including: rim and band A; handle; band B; patch; and bowl C from top to bottom



Cauldron no.	SF no.	Iron				Copper alloys					
		Rim	Band A	Band A2	Handle	Band B	Band B2	Bowl C	Patch	Rivet	Paperclip repair
1	5	J1687	J1687		J1686						
2	7	J1689	J1689		J1688	J1690			J1691		
3	8	J1692	J1692		J1693	J1694		J1695	J1696	J1695	
4	9	J1672	J1672	J1676	J1675	J1673		J1674			
8	82	J1697	J1697		J1698	J1699					
18	4					J1700		J1701			
19	16					J1702		J1703	J1704		
20	23					J1707			J1708		J1709
21	58					J1705	J1706				

Table 6 List of metallurgical samples

Analytical techniques

The sections were mounted in epoxy resin, ground, and then polished using diamond paste to a finish of 1 µm. After examining inclusions and the extent of corrosion, the samples with solid metal present were etched to reveal the metallographic structure. The etchants used were alcoholic ferric chloride on the copper alloy and nital for the iron (Scott 1991).

The metals were examined with a Zeiss AXIOVERT 100A microscope for the metallographic study and a Hitachi S-3700N variable pressure scanning electron microscope (SEM) equipped with energy-dispersive X-ray spectrometry (EDX) for imaging and elemental analysis. The SEM analyses were run at an accelerating voltage of 20kV at low vacuum of 50 Pa and working distance of 10mm. The detection limits for different elements are variable, but are typically in the range of 0.1–0.3%. The relative precision (reproducibility) is about 2% for the major elements and 10% for concentrations in the range 5–20%, and deteriorates as the detection limits are approached.

Results of the analysis of iron components

The results of analysis carried out on the islands of metallic iron using SEM-EDX are shown in **Table 7**. Of the 16 iron samples, 15 were almost completely corroded with only tiny islands of metallic iron remaining; the exception was the handle of vessel 8 where solid metal was present.

Pseudomorphic (relict) metallic structures visible in the corrosion of the samples provided information on the composition of the original metal. The estimated carbon contents were based on the pseudomorphic structures preserved in the corrosion. A small number of inclusions was also analysed and the results are presented in **Table 8**. Bearing in mind that bloomery iron is often heterogeneous, the results presented below only represent a small sample area which may differ from the whole.

Cauldron 1

The rim (hollow type 1) is completely corroded with no metal remaining, the microstructure was not identified and no slag inclusions were found in the corrosion. Band A was also highly corroded. Neither microstructures nor slag inclusions were identified, but a couple of tiny islands of metallic iron containing small amounts of silicon and

phosphorus were present (see **Table 7**). Likewise, the handle has completely corroded with only tiny islands of metallic iron remaining. Analysis of this residual metal revealed that the iron contains a small amount of silicon and phosphorus. A pseudomorphic pearlitic structure present in the corroded metal suggests the iron contained less than 0.3% carbon. Slag inclusions are almost absent except for a few grains of quartz.

Cauldron 2

The iron rim (solid type 1) has completely corroded with iron oxide slag present and a pseudomorphic structure of ferrite-pearlite (see **Table 7**). The outermost surface of the rim displays signs of quenching. It has a heterogeneous structure, with some areas containing ≤ 0.1% carbon and other areas up to 0.4% carbon. The thickness of band A is approximately 1mm, increasing at the top of the band to 2mm. The metal has almost completely corroded with no identifiable microstructure. A few islands of metallic iron containing small amounts of silicon remain. Band A also contains iron oxide inclusions, although fewer than in the rim. The iron handle has corroded with islands of metallic iron remaining. It has a pearlitic structure with the carbon content higher in some areas (up to 0.4%) than others. The sample shows evidence of quenching.

Cauldron 3

The rim (solid type 2) contains islands of metallic iron, and both the rim and band A1 contain trace amounts of phosphorus; however, the rim contains iron oxide inclusions while the upper band (A1) has little slag present; additionally, the band has a higher carbon content than the rim. The sample from the handle contains iron oxide, calcium-rich and silicate slag inclusions (see **Table 7**). The microstructure was not identified except for the presence of pearlites. The flow of slag inclusions was observed in all the components analysed for this vessel, indicating heavy working.

Cauldron 4

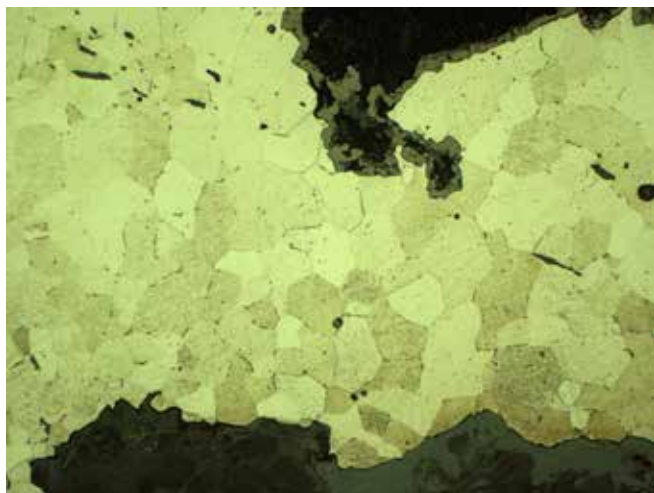
The metal of the rim (solid type 1) and bands A1 and A2 have completely corroded with only pseudomorphic structures present. The rim has a heterogeneous structure with less than 0.2% carbon and higher phosphorus content than the

Cauldron no.	Sample location	Thickness of metal (mm)	Si	Ni	P	S	Microstructure	Estimated carbon content (wt %)	Inclusions
1	rim	2.5					not identified	unknown	absent
	band A	1.5	0.3	nd	0.2	nd	not identified	unknown	absent
	handle	15	0.7	nd	0.3	nd	ferrite-pearlite	≤0.3	a few quartz grains
2	rim	17	0.2	nd	nd	0.1	ferrite-pearlite, surface quenched	≤0.2	oxides
	band A	1	0.2	nd	nd	0.1	not identified	unknown	oxides
	handle	14	0.4	nd	nd	nd	ferrite-pearlite, quenched	≤0.2	silicates and oxides
3	rim	20	0.6	nd	0.1	0.1	ferrite-pearlite	≤0.1	oxides
	band A1	2	0.2	nd	0.1	nd	ferrite-pearlite	≤0.2	absent
	handle	15	0.2	nd	nd	nd	ferrite-pearlite?	≤0.1	oxides, silicates and Ca-rich slag
4	rim	16			present		ferrite-pearlite, surface quenched	≤0.2	Ca-rich and Ca and P-rich silicates
	band A1	1	0.4	0.6	nd	nd	ferrite-pearlite	≤0.3	Mn-rich and glassy oxides
	band A2	1.5	0.5	0.4	nd	nd	ferrite-pearlite	≤0.3	Mn-rich silicates
	handle	16	0.3	0.4	nd	nd	ferrite-pearlite	≤0.3	oxides
8	rim	4.5	0.4	nd	nd	nd	ferrite-pearlite	≤0.2	oxides
	band A	1.5	0.3	nd	nd	nd	ferrite-pearlite	≤0.2	oxides
	handle	15	0.1	nd	nd	nd	ferrite-pearlite	nil – 0.6	oxides

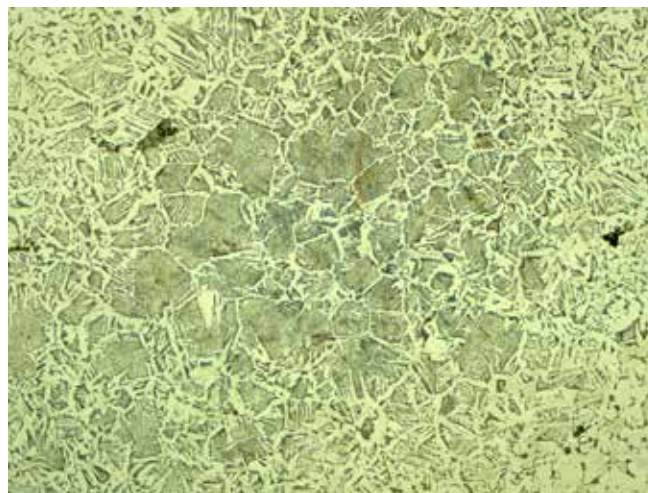
Table 7 Trace elements of iron by SEM-EDX analysis and estimated carbon contents based on its microstructure (nd = below detection limits)

Vessel	Sample location	Na ₂ O	MgO	Al ₂ O ₃	SiO ₂	P ₂ O ₅	SO ₃	K ₂ O	CaO	TiO ₂	MnO	FeO	Inclusion type
1	rim												inclusions are absent
	band A												inclusions are absent
	handle				yes								a few quartz grains
2	rim	0.1	0.9	0.7	0.5	0.1	0.1	nd	0.1	0.1	0.1	97.4	oxides
	band A	0.1	0.1	0.6	0.9	0.3	0.2	nd	0.2	0.1	nd	97.5	oxides
	handle	0.8	4.1	9.2	55.4	nd	0.1	4.2	5.9	0.4	0.5	19.5	silicates
	handle	nd	1.4	0.6	0.6	0.1	nd	nd	nd	nd	0.2	97.3	oxides
3	rim	0.2	0.3	0.3	1.3	0.3	0.1	nd	0.1	nd	nd	97.4	oxides
	band A1												inclusions are absent
	handle	0.1	0.7	0.8	24.5	0.8	0.2	nd	1.8	nd	0.3	70.9	silicates
	handle	nd	nd	0.7	0.8	0.3	0.1	nd	0.4	0.2	nd	97.5	oxides
	handle	nd	0.1	0.1	0.5	2.5	0.2	nd	64.4	nd	nd	32.2	Ca-rich slag
4	rim	0.4	0.8	0.8	20.0	11.8	nd	0.2	10.4	0.6	0.8	54.2	Ca and P-rich silicates
	rim	3.4	1.0	6.2	59.8	nd	0.2	4.4	10.0	0.4	0.9	13.7	Ca-rich silicates
	band A1	nd	nd	0.9	0.5	nd	nd	nd	nd	nd	4.1	94.5	Mn-rich oxides
	band A1	nd	nd	2.0	7.8	0.5	0.3	nd	0.3	nd	nd	89.1	glassy slag
	band A2	0.1	1.4	0.4	26.5	0.4	nd	nd	1.2	nd	5.1	64.9	Mn-rich silicate
	handle	nd	0.1	0.8	0.9	0.3	0.2	nd	0.1	nd	nd	97.7	oxides
8	rim	0.2	0.2	0.7	1.3	0.1	0.2	nd	0.2	0.2	nd	96.9	oxides
	band A	0.1	0.3	0.6	0.7	0.1	nd	nd	0.3	0.2	0.1	97.8	oxides
	handle	nd	0.1	0.9	9.2	0.3	nd	0.2	0.5	0.2	0.3	88.4	oxides
	handle	0.1	0.2	1.8	21.7	0.4	0.6	0.4	1.5	0.2	0.3	72.9	glassy slag

Table 8 Composition of inclusions of the iron by SEM-EDX



a



b

Figure 87a–b The structure of iron in the handle of cauldron 8 a: ferritic structures; b: near-eutectoid structure

bands. It contains silicate type slag, including calcium-rich as well as calcium and phosphorus-rich silicates (**Table 7**). The corroded metal of band A1 retains some iron carbides, suggesting higher carbon content than the rim, perhaps less than 0.3%. It contains manganese-rich and glassy slag, both containing mainly iron oxides (see **Table 7**). The lower iron band A2 also has carbides and manganese-rich slag inclusions present as well as islands of metallic iron containing small amounts of nickel and silicon. The microstructure of the iron was not identified but it contains probably no more than 0.3% carbon. The outmost surface of the rim displays typical structures of quenching. Neither of the bands appeared to have been quenched, as the presence of carbide indicates a slow cooling. The upper iron band (A1) thickens from 0.6 to 2mm at the top.

The iron handle is completely corroded with a pseudomorphic pearlitic structure and a couple of tiny islands of metallic phase that contain less than 0.3% carbon. Analysis of the residual islands of metal revealed that the iron contains small amounts of nickel and silicon and a large quantity of iron oxide slag inclusions. The flow of slag inclusions was observed in the band and handle of vessel 4, indicating heavy working; additionally slip lines were present along the circumference of the handle.

Cauldron 8

The rim (hollow type 1) is completely corroded with islands of metallic iron remaining. The metal contains trace amounts of silicon and iron oxide inclusions and has a pearlitic structure. Band A has completely corroded except for islands of metallic iron with a pearlitic structure and oxide inclusions. The iron handle is the only sample from Chiseldon with solid metal remaining and contains many slag inclusions. The iron has a heterogeneous structure with carbon contents ranging from almost nil to c. 0.8% (see **Fig. 87a–b**). Some areas have ferritic structures (almost pure iron) with iron carbide (Fe_3C) on the grain boundaries (**Fig. 87a**), other areas have a near-eutectoid structure with c. 0.8% carbon (**Fig. 87b**), consisting almost entirely of pearlite (alternating lamellae of ferrite and iron carbide) and the rest have varying mixtures of pearlite and ferrite.

Discussion of iron samples

Technology

Rim construction

The five cauldrons sampled displayed three of the four rim manufacturing methods identified in Chapter 6. The polished cross sections of the rims allowed a more detailed examination of the methods of manufacture.

Cross sections of the rims of cauldrons 2 and 4 (solid rim type 1) (**Fig. 88a**) indicate this type of rim was probably made by partially splitting a round-sectioned bar with a chisel while at red heat to create a groove into which band A was inserted. Thickening at the top edge of band A on both cauldrons 2 and 4 may have been caused by hammering from the top to strengthen the iron before the rim was fitted. The surfaces of the rims of both vessels appear to have typically quenched relict structures, indicating the iron band was inserted into the groove and the assemblage thrown into cold water, causing the rim to contract and firmly grip the band. They were probably quenched after being heated to a temperature of around 900°C. It is also possible that the iron band was hammered on the vessel interior close to the gap between the rim and the band.

Cauldrons 1 and 8 were examples of hollow type 1 rim (**Fig. 88b**) produced by forging a strip of sheet metal into a tube, into which band A was inserted, and then hammering to close the gap on both sides of the band. The sheet metal for this type of rim was 2–5mm thick in its current form, but must have been thinner originally. No sign of quenching was found in these samples.

A cross section of the rim of cauldron 3, identified as a solid type 2 rim, supports the assumption that there was no mechanical joining of the rim to band A apart from the four clips, again supporting the idea that this may have been a later repair (**Fig. 88c**).

Working of bands and handles

Strain lines present in the pseudomorphic metallic structures along the circumference of the circular section of the handle of vessel 4 (**Fig. 89**) indicate that the handle was

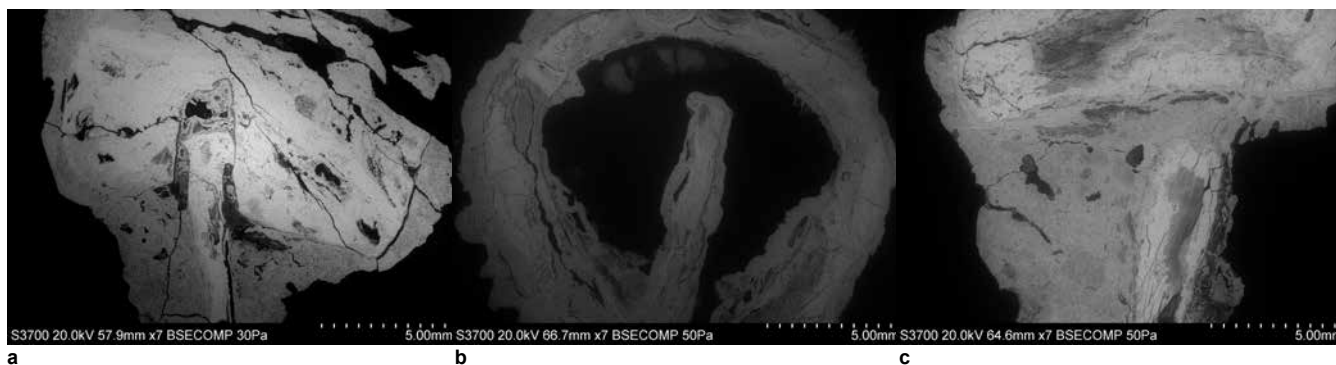


Figure 88a–c Cross section of cauldron rims: a) solid type 1 (cauldron 4); b) hollow type 1 (cauldron 1); c) solid type 2 (cauldron 3)

probably formed by repeated hammering while the iron bar was rotated. The flow of slag inclusions was observed in the band and handle of vessel 4 indicating heavy working.

Analysis of the handle of cauldron 8 reveals a structure typical of heterogeneous bloomery iron from the Iron Age. Although the carbon content in this sample falls in the range for steel (containing 0.1% to 2% carbon), the sample studied is small and has a very heterogeneous structure with a large amount of slag inclusions. Partial carburisation of the iron could have occurred accidentally during the smelting or forging processes. It is also possible that the iron bar used for the handle was made by forging together several pieces of bloomery iron, indicated by the accumulation and elongation of slag inclusions and the very heterogeneous structure, but the evidence is inconclusive. Härker and Salter (1984) argued that the flow of slag inclusions provides evidence for heavy working. This was observed in some of the samples studied here, such as the iron rim and band of vessels 3 and 4. It is probable that most of the iron used in the cauldrons was low carbon iron which would have been relatively easy to forge to shape using a number of working and heating cycles.

Metal provenance and compositional comparisons

Provenance

Analysis of slag inclusions and metal can provide information on iron provenance and the extraction processes involved (Buchwald and Wivel 1998; Paynter 2006; Dillmann and L'Héritier 2007; Blakelock *et al.* 2009; Charlton *et al.* 2012). Unfortunately, analysis of the ferrous samples from the vessels did not provide sufficient data owing to the corroded state of the metal. It is difficult to draw any further conclusions on provenance based on the analyses but they are consistent with analyses from other Iron Age material.

Comparison of metal composition between components

Analysis of the samples enabled comparisons to be made between individual iron components of the vessels. Of the five vessels analysed, the results from three, cauldrons 1, 2 and 8, indicate that individual components of each of the cauldrons may have been made from a single or similar blooms (a porous mass of iron and slag produced from smelting iron ores).

The similarity of microstructure and slag inclusions in the iron of the rim, band A and handle of vessel 2 suggests

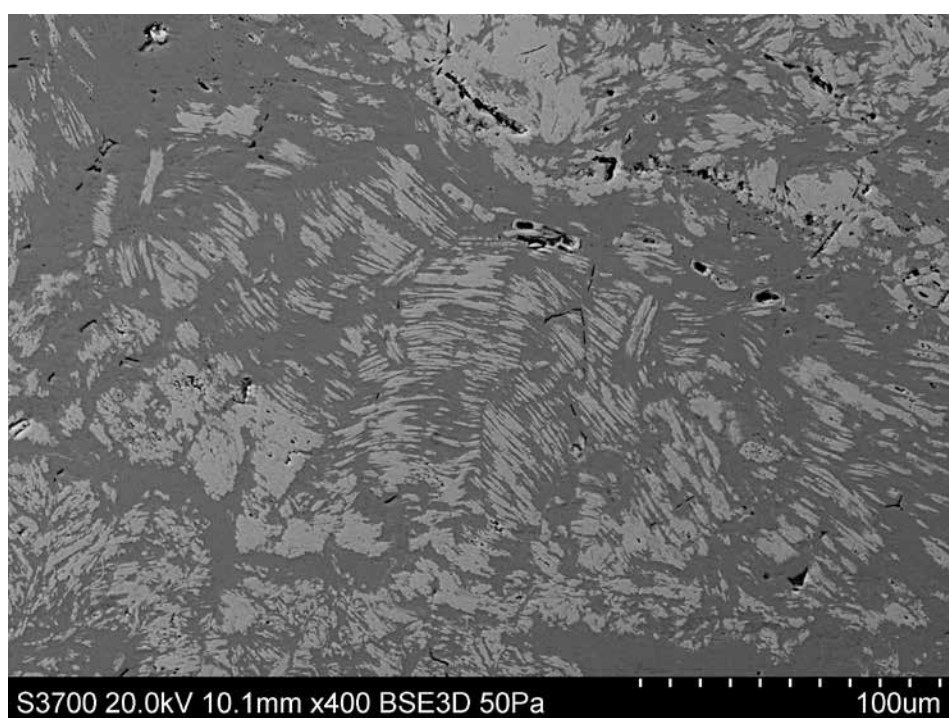


Figure 89 Back scattered electron image of strain lines in the pseudomorphic structure of iron from the handle of cauldron 4

that all these components were probably made from the same bloom or blooms of the same ore source.

The similarities in the microstructure and in the slag inclusions suggest that all the iron components of cauldron 8 were likely to have been made from the same ore source or even from a single bloom.

Despite the unidentified microstructure of the rim and band of cauldron 1 (due to the heavily corroded state of the sample) the similarities in trace elements in the remaining islands of metallic iron and in the slag inclusions suggest that all these components, including the handle, are likely to be from the same bloom or blooms of the same ore source.

The presence of manganese-rich slag inclusions in both the upper A1 and lower A2 iron bands of vessel 4 (see **Table 7**) suggests that they may have come from the same ore source, probably bog ores, which often contain manganese and phosphorus (Craddock 1995). The similarity in composition of bands A1 and A2 confirms that the two bands were contemporaneous. However, the microstructure and slag inclusions of the rim, and the absence of nickel as a trace element (which is unlikely to be an intentional element for altering the working properties of the iron) may indicate that the rim comes from a different source. Despite the absence of manganese-rich slag inclusions the handle could have been made using similarly sourced ores to the bands, as indicated by presence of nickel in the iron.

Results from the analyses of cauldron 3 components, which reveal a difference in slag inclusions between the rim and band A1, suggests different ore sources or a heterogeneous bloom and support the idea that the unusual rim construction of this vessel may be a repair.

Compositional differences between cauldrons

The results of the analysis show differences in composition of the iron between the cauldrons, indicating that the vessels were probably made in different circumstances. On comparison of the components of the two solid-rimmed cauldrons 2 and 4, there was a difference in metal composition and slag inclusions suggesting different ore sources for these two vessels. Similarly, when the iron composition for the hollow rim cauldrons 1 and 8 was compared, the variance in metal composition and slag inclusions suggest different ore sources for these two vessels. Though the vessels with the same type of rim fitting may have been made in the same workshop, they must have been made using different blooms from different sources, probably at different times. The sample size of two per cauldron type is small, therefore other vessels within the hoard would need to be analysed to confirm these findings.

Analysis again revealed compositional differences in the iron of the handles of vessels. Calcium-rich slag found in the handle of cauldron 3 was not found in the handle of cauldron 1, suggesting that the metal sources for the handles of the two cauldrons were probably different. The handle of cauldron 4 (which contains nickel) was also probably made from a different source of metal from the handle of cauldron 1, which contains phosphorus rather than nickel and is nearly slag-free. All this evidence suggest that the three handles were probably made from different ore sources at different times.

Results of analysis of copper alloy components

The majority of the copper alloy studied was in a reasonably good condition with some solid metal remaining. All the samples (from bands, bowls and patches) indicate that the copper alloy sheet was thinner than 0.5mm. The analytical results, including the extent of corrosion, thickness of the sheet metal, alloy composition, and inclusions in the alloys, are summarised in **Table 9**.

Cauldron 2

Band B contains 6.7% tin, the lowest tin content of all the samples studied. The lead content (0.8%), higher than in most of the other samples, is still small enough to indicate accidental inclusion rather than an alloying element. Some lead has been lost through corrosion leaving voids in the metal and lead corrosion products on the surface. The lower degree of elongation of the sulphide inclusions (see below) indicates the metal sheet has been subjected to a smaller reduction in thickness than the copper alloy of the other Chiseldon vessels.

The copper alloy patch along the A/B join is corroded, with no sound metal remaining. The metal appears to have been a binary bronze, but owing to the extent of corrosion it was not possible to obtain a quantitative composition for comparison to band B. The structure is equi-axed with elongated sulphide inclusions (longer than those in the band indicating a greater reduction in thickness) and a few ($\alpha + \delta$) eutectoid grains present in the corrosion.

Cauldron 3

The band and the bowl have tin contents of 10.1% and 9.0%, respectively. Bismuth is present in the lead globules of band A but not the bowl, suggesting either different ore sources or a variation in the same ore. The elongation of the sulphide inclusions in the bowl are more severe than in the band, indicating that the bowl was subjected to a higher level of working, which suggests that the blank for the bowl was originally cast thicker than that for the band, as they are now of a similar thickness (see **Table 9**).

Analysis of a patch on the bowl C indicates the alloy composition is not close enough to have been made from an offcut of the band or bowl; however, the location of the patch between the B/C join implies that it was applied during vessel construction.

The rivet from along the B/C join has a tin content of 14%, significantly higher than other vessel components. The higher tin content was probably not intended to alter the properties or hardness of the metal. The distortion of the sheet and the elongation of the sulphide inclusions towards the exterior of the bowl at the rivet-bowl junction indicate that the rivet from along the B/C join was inserted from the interior and flattened out on both surfaces with more hammering on the exterior of the bowl. The rivet was subjected to less working and annealing than the bowl and the band, as evidenced by the less elongated sulphide inclusions and the presence of residual ($\alpha + \delta$) eutectoids.

Cauldron 4

The composition of the band and bowl are very similar with a tin content of 12% and 12.2% respectively, although there

Cauldron no.	Sample location	Condition: Depth of corrosion	Thickness of metal (mm)	Cu	Sn	Pb	As	S	Fe	Co	Fe present in sulphide inclusions	Other inclusions	Remarks on microstructure
2	band B	surface corrosion	0.3-0.4	91.7	6.7	0.8	0.2	0.1	0.1	nd	y		
	patch on band	all way through with islands of metal remaining	0.2-0.3	y	y		y				y		
3	band B	half way through	0.2-0.3	87.9	10.1	0.2	0.8	0.2	0.2	0.1	y	Bi present in Pb globules	
	bowl	surface corrosion	0.2-0.4	88.3	9.0	0.9	0.8	0.3	0.3	0.3	y		
	rivet on bowl	surface corrosion		82.7	14.0	0.5	1.1	0.7	0.4	0.3	y		residual eutectoids
	patch on bowl	half way through	0.3	89.4	8.5	0.3	0.7	0.2	0.2	0.1	y		
4	band B	half way through	0.2	86.4	12.0	nd	0.9	0.1	0.1	0.1	y		residual eutectoids
	bowl	surface corrosion	0.2-0.3	86.2	12.2	nd	0.4	0.2	0.4	0.2	y		
8	band B	all way through with shape being retained	0.3-0.4	85.9	11.8	0.2	0.7	0.5	nd	0.2	n		
18	band B	all way through with a thin layer of metal remaining	0.3-0.4	84.3	14.4	nd	nd	nd	0.5	nd		Ag	residual eutectoids
	bowl	surface corrosion	0.2	86.8	12.3	nd	nd	0.1	0.2	nd	y		
19	band B	half way through	0.3	89.7	8.8	nd	0.6	0.4	0.1	0.1	n	Ag	
	bowl	surface corrosion	0.4	86.0	12.5	0.3	0.5	0.3	0.2	0.2	n		residual eutectoids
	patch on bowl	half way through	0.3-0.4	89.8	8.0	nd	0.9	0.5	0.1	nd	n		
20	band	half way through	0.3	88.0	10.7	0.1	0.4	0.5	nd	nd	y		
	patch on interior of the band	surface corrosion	0.2	87.2	11.7	0.2	0.2	0.4	0.1	nd	y	Bi present in Pb globules	
	paperclip repair to the band	surface corrosion	0.2	87.1	11.4	0.1	0.2	0.4	0.4	nd	y	Bi present in Pb globules	
21	band B1	half way through	0.3	88.8	10.2	nd	0.2	0.2	0.1	0.2	y		
	band B2	half way through	0.4-0.5	89.7	9.2	0.1	0.3	0.1	0.1	nd	n		

Table 9 SEM-EDX results of the copper alloy bands, bowls, patches and rivets

are higher concentrations of sulphide inclusions in the bowl. The elongation of sulphide inclusions reveals that there was a greater reduction in the thickness of the bowl (> 80%) than the band (> 60%). The blanks for the bowl and the band were probably cast separately, with the band cast thinner but subjected to smaller reduction in thickness than the bowl (as for cauldron 3). The presence of residual ($\alpha + \delta$) eutectoid phases in the band indicates insufficient annealing, perhaps because of low temperatures.

Cauldron 8

Only the copper alloy of the band was analysed for this cauldron. Although the metal is badly corroded, the

evidence of working and annealing is shown by the recrystallised equi-axed structure with elongated sulphide inclusions. SEM-EDX analysis indicated a tin content of 11.8%, although in the original metal it may have been a little lower because surface corrosion is often enriched with tin.

Cauldron fragment 18

The copper alloy of band B is badly corroded with little metal remaining while the bowl is in a better condition. The band and the bowl contain 14.4% and 12.2% tin respectively, and fewer impurities than other samples. Tiny quantities of silver as an impurity were found in the band but not the



Figure 90 Photomicrograph of the bronze patch from the bowl of cauldron fragment 19. Image width: 0.27mm

bowl. Residual eutectoid phases present in the band are the result of high tin levels and insufficient annealing. The sulphide inclusions are less elongated than in other bronze samples from the cauldrons, suggesting a smaller reduction in the thickness of the blank.

Cauldron fragment 19

Band B contains 8.8% tin and a few very tiny silver globules, but no lead inclusions.

The composition of the bowl is markedly different containing 12.5% tin. Residual ($\alpha + \delta$) eutectoids present in the microstructure indicate insufficient annealing. The sheet of band B appears thinner than the bowl C although subjected to a similar degree of working as revealed by the elongation of sulphide inclusions.

Analysis of a patch covering a stress fracture at the bowl edge reveals that its alloy composition is similar to band B, possibly an offcut, and indicates the patch was probably applied at the time of manufacture, as supported by its location between the B/C join. The patch has a fully recrystallised structure with severely elongated sulphide inclusions (**Fig. 90**).

Cauldron fragment 20

The band is corroded with a modest amount of metal remaining, while both the patch and the paperclip repair on the interior of the band are in a relatively good condition with a thin corrosion layer on the surface. The band contains 10.7% tin and many sulphide inclusions while the paperclip repair and the patch have almost identical tin contents (11.4% and 11.7% respectively) and both contain lead particles with bismuth, and sulphide inclusions containing iron.

Cauldron fragment 21

Bands B1 and B2 are badly corroded with metal remaining in the centre. The tin content in the upper and lower bands is 10.2% and 9.2% respectively with lead virtually absent

from either band. Iron was detected in the sulphide inclusions of the upper band but not in the lower band. The lower band has fewer but more elongated sulphide inclusions than the upper band indicating a greater reduction in thickness from the blank.

Discussion of copper alloy samples

Working

Traditional techniques for forming bronze sheet have remained the same since the Bronze Age and are described in textbooks (e.g. Wakeford 1985). The initial stage was to cast a blank in a stone, clay or sand mould, and examples of blanks and moulds have been found in Iron Age and Roman contexts (Cunnington 1920; Gwilt 2007; Northover in Gerloff 2010, 37–43). The blank was then forged to the desired thickness by numerous cycles of working and annealing and then scraping (Lindsay Publications 2004). By examining surface tool marks, it is sometimes possible to identify the production techniques, and this is discussed further in Chapter 6.

All of the copper alloys examined displayed the typical features of worked sheet bronzes; recrystallised equi-axed grain structures with annealing twins and very elongated sulphide inclusions resulting from many cycles of hammering and annealing (**Fig. 90**). Recrystallisation of metal can occur as a result of heating during object use; however, the very elongated sulphide inclusions in all the cauldron samples studied suggest that it was a result of sheet metal production. Cast bronze with a 5–15% tin content, on the other hand, has a distinctive dendritic structure consisting of matrix α phase (the copper-rich solid solution of tin in copper, usually cored) and the second phase of eutectoid ($\alpha + \delta$).

When annealing is not sufficient (due either to low annealing temperature or inadequate cold working and annealing time), residual coring or a eutectoid ($\alpha + \delta$) phase can be present. Fully recrystallised equi-axed grain

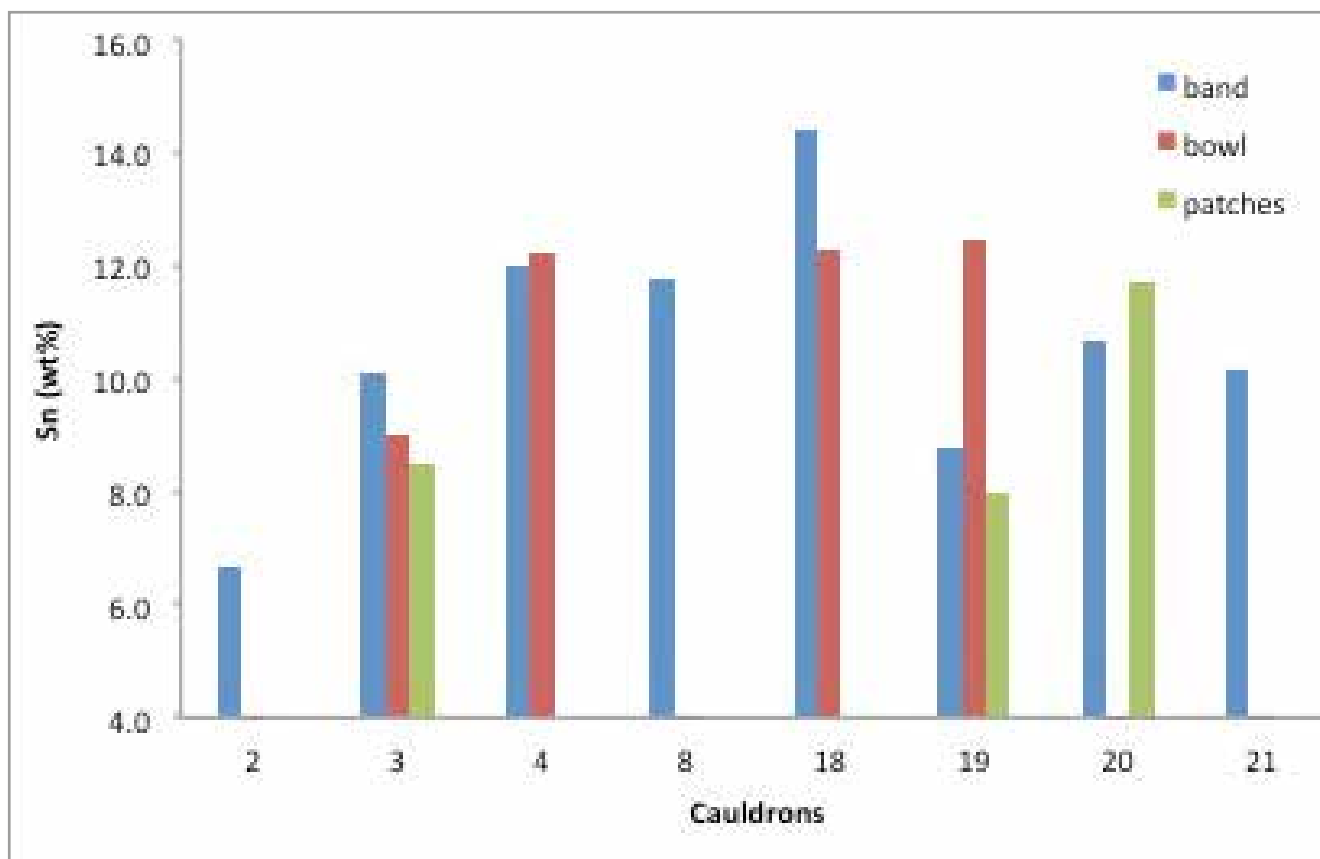


Figure 91 Tin contents (weight %) of the bronzes

structures indicate a sufficient annealing temperature, usually 650–700°C (Wang and Ottaway 2004) and were observed in most of the Chiseldon samples. However, some samples from Chiseldon showed residual traces of the ($\alpha + \delta$) eutectoid phase (see **Table 9**), indicating that annealing was incomplete, notably on cauldron fragment 18, which may explain the presence of numerous stress fractures and patching at the A/B join.

If hammering was the last stage of the working–annealing cycle, strain lines may be present in the microstructure of a fresh metal; if annealing was the last stage, annealing twins are expected in the grains. All the Chiseldon samples seem to have been left in a slightly cold worked condition indicated by the presence of strain lines (mostly on the surface) and little distortion of the annealing twin lines in the microstructure.

The sulphide inclusions present in copper as grains or dendrites (Wang 2002) stretch with prolonged working in the same direction, forming straight lines (elongation) in the microstructure of the metal and indicate the direction of working. The degree of elongation may be indicative of the amount of working and thickness reduction that has occurred (Northover 1996; Baboula and Northover 1999). However, sulphide inclusions can be of different shapes and resist deformation to different degrees (Wang and Ottaway 2004). Elongated sulphide inclusions in the Chiseldon sheet metal indicate varying degrees of working and reduction in thickness between the finished sheets and the original blanks. Based on comparison with experimental studies (Wang and Ottaway 2004), cauldron 4 may have been reduced in thickness by 80% or more. For three samples

(cauldrons 3, 4 and 19), for which both the bowl and band B were analysed, it appears that the bands were cast thinner and worked less than the bowls. However, it is difficult to ascertain if this was always the case because of the small number of vessels analysed.

Alloy composition and provenance

All the sheet metal analysed from the Chiseldon cauldron group was tin bronze with low levels of impurities. Tin content in the samples varies between 6.7 and 14.4 wt%. Out of the 19 samples, 16 are in the range of 8.0–12.5% with an average tin content of 11.0% (**Table 9**, **Fig. 91**). The Chiseldon samples were found to contain less than 1% lead, present as an impurity rather than an alloying element. Lead is insoluble in copper and present as globules, making the bronze difficult to work into sheet. In the Late Bronze Age in Britain, although leaded bronzes were used for cast objects, lead-free metal was retained for sheet bronze. The use of lead as an alloying element for cast bronze objects declined in the last phase of the Bronze Age (Northover in Gerloff 2010, 37–43) and low levels of lead found in most Iron Age alloys are probably impurities (e.g. Dungworth 1997).

Most Iron Age copper alloys from Britain are tin bronzes with 0.1–1.0% arsenic present as the most common impurity (Dungworth 1996; 1997). The tin content of Iron Age bronzes found at sites in southern Britain varies greatly; for example, bronzes found at Hengistbury Head, Dorset contain 3–16% tin (Northover 1987), bronzes found at Gravelly Guy, Stanton Harcourt, Oxfordshire contain 6.5–13.5% tin (Northover in Lambrick and Allen 2004, 88–90), while a few bronze objects (including a bowl and

scabbards) found in a Late Iron Age warrior burial from Kelvedon, Essex have similar alloy compositions with 11–12% tin (Northover 2007; Joy 2010). It has been reported by Dungworth (1996, 402) that in northern Britain cast objects tend to have higher tin levels (average = 11.2%) than wrought objects (average = 8.8%). Although this is the case for mirrors (Joy 2010), it is not known if this applies to all types of object from southern Britain. While the Chiseldon cauldrons have an average tin content of 11.0%, no other classes of bronze objects are available from the site for comparison. Whether there is a difference in the composition of cast and sheet objects in southern Britain is inconclusive based on published data.

The geographic distribution of impurities existent in copper alloy objects has been studied in the past, and impurities in alloys have been used by Northover (in Cunliffe 1984a, 430–3; in Sharples 1991, 156–62; in Cunliffe and Poole 1991, 407–12; in Lambrick and Allen 2004, 346–54) to determine the source of copper for Iron Age bronzes. The principal impurities are usually arsenic (As), antimony (Sb), cobalt (Co) and nickel (Ni) (and sometimes silver is included) but cobalt is the key impurity for bronzes from southern England (Peter Northover pers. comm.). Arsenic, lead, iron and cobalt are all common impurities in the samples from Chiseldon, and additionally silver grains as an impurity were found in fragments 18 and 19, but their presence is not understood. Although the technique (SEM-EDX) used is not sufficient for trace element analysis, the cobalt detected in some samples from Chiseldon has a maximum level of 0.3%, similar to objects found at Gravelly Guy (Northover in Lambrick and Allen 2004, 346–54) and Hengistbury Head (Northover 1987). The sulphide inclusions present in most samples (see **Table 9**) were found to contain a small amount of iron, suggesting that iron-containing copper sulphide ores were probably used for these vessels.

Provenance studies of bronze are never straightforward, and without accurate trace element analyses and a known database with which to compare them, caution is needed in interpreting trace elements in terms of ore source (Dungworth 1997). Additionally, widespread recycling of metal in the Iron Age makes determining provenance more complicated. However, based on comparisons with analysis of material from other sites, most of the samples analysed are probably of southern British origin.

Comparison of components

Based on the evidence of alloy compositions and microstructures of the samples studied, the blanks of different bronze components for a single cauldron are likely to have been cast separately. However, in terms of interpreting similarities and differences between parts of the same cauldron and between individual cauldrons, the results are largely inconclusive.

The metal of the band and bowl of cauldron 18 shows similarities, both parts containing fewer impurities than the other Chiseldon samples; however, tiny quantities of silver are present in the band but not the bowl, suggesting different ores or variations of the same ore.

The band and the bowl of cauldron 3 have similar tin contents of 10.1% and 9.0% respectively. However, bismuth

is present in the lead globules of band B but not in the bowl, suggesting that either ores from different sources were used or there was a variation in the same ore. The band and bowl are likely to have been made in different melts judging by the differences in the levels of lead in the two samples; however, lead often has an uneven distribution in metal. Analysis of a sample from the patch on bowl C indicates that the alloy composition is not close enough to be an offcut of the band or the bowl.

The analysis of metal from the band and bowl of cauldron 4 reveals that the alloy compositions are very similar; however, the microstructures reveal a higher concentration of sulphide inclusions in the bowl, indicating that either different copper ores have been used or the ore had been refined to different levels.

The bowl and band of cauldron 19 seem to have been made from separate melts, as the tin contents at 12.5% and 8.8% are markedly different. Analysis of a patch covering a stress fracture at the bowl edge reveals that its alloy composition is very similar to band B (possibly it is an offcut) and indicates the patch was probably applied at the time of manufacture, as supported by the location of the patch between the B/C join.

A comparison of the results for the fragments of copper alloy sheet 20 and 21 found in the same area of the pit could not prove whether they came from the same vessel, as a difference in sulphur content is evident despite similarities in other elements. Additionally, it is inconclusive whether both bands of cauldron fragment 21 were from the same melt based on the alloy compositions. Analysis was unable to determine whether the patch and paperclip repair present on fragment 20 were cut from the sheet metal used for band B, but the similarity in composition of the two repairs to each other may indicate that these patches were applied at the same time, despite the difference in style of the repair.

Conclusions: iron and copper alloys

It was not possible to identify the provenance of the iron due to the condition of the metal, or of the bronzes without accurate trace element analyses and a known database with which to compare them. But, based on comparisons with analysis of material from other sites, most of the copper alloy samples are probably of southern British origin. The majority of the copper alloy samples studied were in a reasonable condition with solid metal remaining. The copper alloys are all tin bronzes with the tin content varying between 6.7 and 14.4 wt%. Arsenic, lead, iron and cobalt are common impurities in most samples and sulphide inclusions (most associated with iron) are present in all the samples.

Four of the five cauldrons studied showed that, for the iron at least (the copper alloy analysis being largely inconclusive), components of individual cauldrons may have been made from the same metal. The exception was cauldron 3 where the rim and band were not similar in composition, supporting the theory that the unusual rim structure may have been a repair. Different bronze components for a single cauldron are likely to have been cast from separate blanks based on the evidence of alloy compositions and microstructures of the samples studied.

All these factors indicate that the vessels, although possibly displaying some regional similarities, were probably constructed at different times and collected together for a particular occasion and eventually burial.

The construction of the cauldrons is technologically complicated. The use of quenching to fit the iron rim to the iron band A is one of the techniques developed by Iron Age blacksmiths. The production of the copper alloy bowls takes the metal to its limits. The reduction in thickness was possibly over 80% in some samples, with all the sheet analysed thinner than 0.5mm and the thinnest sample 0.2mm. The high degree of thickness reduction in the copper alloy sheet metal indicates the extraordinary skill

and intensive labour involved in the construction of the vessels. These large and complicated vessels must have required multiple phases of working. All the copper alloys examined have recrystallised equi-axed grain structures with annealing twins and very elongated sulphide inclusions resulting from many cycles of hammering and annealing, and are typical of sheet bronzes. All the copper alloys sampled have been left in a lightly cold worked condition. The metallurgical study also suggests that some repairs and patches are likely to have been part of the manufacturing process rather than later repairs due to damage. This is an important finding which has not previously been raised as a possibility in the literature.

Chapter 9

Analysis of Partially Carbonised Residues from the Chiseldon Cauldrons by Gas Chromatography-Mass Spectrometry and Gas Chromatography-Combustion-Isotope Ratio Mass Spectrometry

Val Steele

During the micro-excavation of the cauldrons, residues were identified which appeared different from the surrounding soil and metal corrosion products. Thirty-seven of these residues from nine cauldrons and two significant fragments of incomplete cauldrons were analysed by gas chromatography-mass spectrometry (GC-MS) along with two samples of soil from the micro-excavation for comparison. The aim of the analysis was to determine whether these residues contained any organic material related to the use of the cauldrons, specifically lipids (fats, waxes, resins etc.) from the preparation of food or drink. Two of the samples from the cauldrons were also sent for compound specific carbon stable isotope analysis by gas chromatography-combustion-isotope ratio mass spectrometry (GC-C-IRMS) to give a more precise identification of the residues.

Samples

The samples were removed using clean tools and placed in glass vials, with two exceptions (24 and 25) which were stored in plastic capsules. Twenty-five samples were collected from the surfaces of the copper alloy sheets forming the bases and sides of the cauldrons – 20 from interior and five from exterior surfaces. A further seven samples were taken from between the copper alloy sheets at the riveted joints. The remaining five samples were associated with the iron band at the top of each cauldron. One sample from cauldron 2 was retrieved from the joint between the decorative cattle-headed handle plate and the iron band on which it was mounted. Two of the other three samples from cauldron two came from the surface of the iron band of cauldron 5, with the third coming from an iron rim fragment which may be from cauldron 5 or 6. The final sample was from the joint between the iron band and the copper alloy sheet making up the body of cauldron 1.

It was surmised that the residues on the surface of the metal sheets might have formed during the use of the cauldrons and consist of the semi-carbonised remains of the foods or other materials heated in the vessels. Such residues form and survive on the surfaces of ancient and ethnographic ceramic and stone cooking vessels and there was no reason to assume that they could not form and be preserved on metal surfaces. The residues from the riveted joints could also be the remains of the vessel contents which had seeped into the cracks formed by the joints during use. However, an alternative explanation for the latter residues is that the joints were deliberately packed with plant material and/or resinous or waxy material to seal the joints.

Two soil samples from the fill of cauldron 4, taken in the same way, were analysed for comparison with the residues. The samples are summarised in **Table 10**.

Experimental methods

Initially sub-samples from three residues were solvent extracted using a dichloromethane/methanol mixture. However, this extracted very low amounts of organic material from the carbonised matrix, so all further samples were extracted using alkaline saponification (Regert *et al.* 1998; Regert *et al.* 2001). A few of the samples which yielded larger amounts of organic material were subsequently prepared by

Sample no.	Cauldron no.	SF no.	Description
1	3	8	Grey/brown, fibrous material from interior of cauldron
2	3	8	Grey/brown residue from interior of cauldron
3	3	8	Dark brown/black residue from riveted joint
4	19	16	Flaky, dark residue with pale surface layer from riveted joint between bowl and central band
5	19	16	Flaky, dark brown residue from interior surface of bowl
6	4	9	Very flaky, dark reddish-brown residue from interior base of cauldron
7	4	9	Dark brown, flaky residue with pale surface layer from interior base of cauldron
8	4	9	Lumpy, very dark brown residue with pale surface layer from interior of cauldron base
9	1	5	Lumpy, inhomogeneous, dark residue from joint between iron rim and copper alloy central band
10	19	16	Whitish/pale residue from riveted joint between copper alloy bowl and central band
11	19	16	Lumpy, red-brown residue from interior surface of bowl
12	4	9	Flaky, dark brown residue with pale surface from joint between copper alloy sheets
13	4	9	Whitish residue from interior of copper alloy band
14	4	9	Soil sample from the fill of cauldron
15	4	9	Soil sample from the fill of cauldron
16	2	7	Crumbly, dark red-brown residue from joint between iron band and decorative, iron, cow-head-shaped handle plate
17	4	9	Flaky residue with pale surface layer and pale green areas from interior surface of cauldron
18	4	9	Pale, greyish residue from riveted joint between copper alloy sheets
19	11	23/123	Greyish brown residue with a green layer on one surface from interior surface of copper alloy sheet of fragment
20	11	23/123	Blackish residue with significant paler areas from exterior surface of copper alloy sheet of fragment
21	2	7	Flaky, dark residue with pale surface from interior surface of band B
22	2	7	Black, crusty residue with paler surface and green areas from exterior surface of band B
23	10	105	Sample of large, dense residue layer on interior surface of copper alloy band initially thought to be corrosion products
24	10	105	Black, sooty residue from exterior of copper alloy bowl and central band
25	10	105	Whitish residue from interior of central copper alloy band
26	10	105	Blackish residue from exterior of central copper alloy band
27	1	5	Black material from interior surface of copper alloy band close to joint with iron rim
28	1	5	Blackish material from exterior of copper alloy sheet
29	5	10	Blackish residue from riveted joint between band B and bowl C with pale surface and distinct greenish area
30	5	10	Flaky, dark residue with pale surface layer from interior surface of band B
31	11	123	Flaky, dark residue with pale surface from interior surface of bowl C
32	2	7	Dark residue with pale surface and green areas from interior of band A
33	5 or 6	10/11	Lumpy, dark residue with reddish areas from decorated section of iron rim, above decoration
34	2	7	Very flaky, dark residue with pale surface and green areas from interior surface of cauldron body
35	5 or 6	10/11	Very dark, powdery residue from interior of copper alloy band
36	12	149	Very dark residue with greenish layer from interior side of joint between copper alloy band and a scalloped copper alloy patch
37	5	10	Flaky, dark residue with pale surface layer from a scalloped copper alloy patch at the top of band B adjacent to/riveted to iron rim
38	5	10	Slightly powdery, very dark residue with pale, flaky surface layer and red patches from exterior side of riveted joint between copper alloy bowl and band B
39	5	10	Gravelly, dark, reddish-brown residue with one paler area from interior surface at bottom of iron band

Table 10 Details of the samples analysed

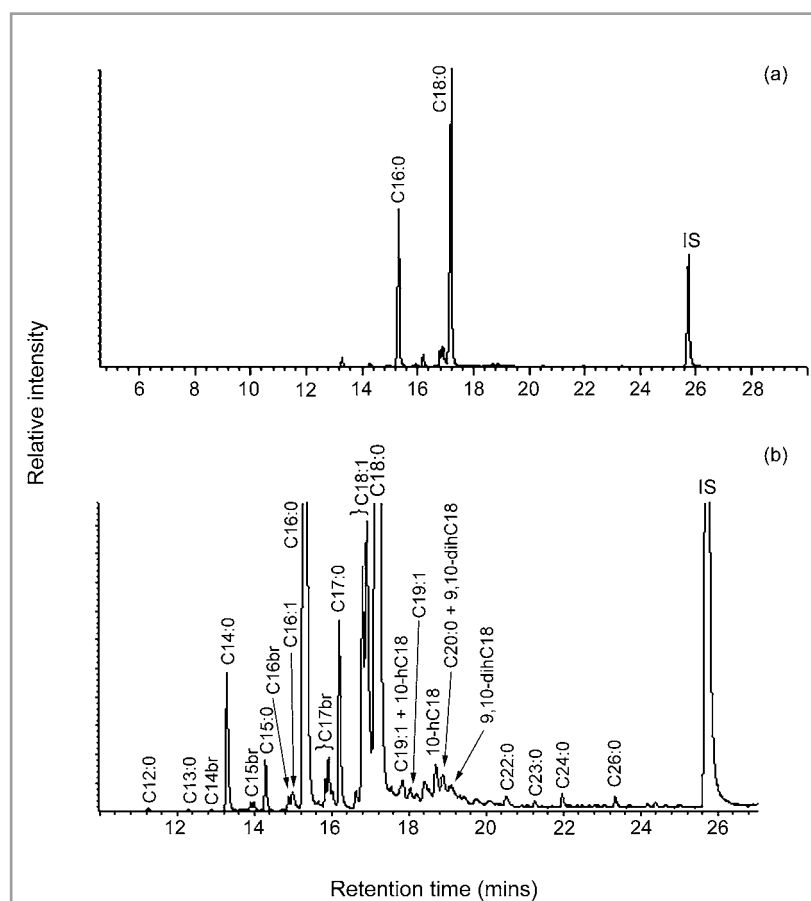


Figure 92a–b a) total ion chromatogram of the saponified residue from sample 11; b) an enlargement of the area between 10 and 27 minutes retention time. Key: Cx:y – fatty acid with x carbon atoms and y double bonds; Cxbr – branched, saturated fatty acid with x carbon atoms; n-hCx – hydroxy fatty acid with x carbon atoms, hydroxyl group at atom n; n,m-dihCx – dihydroxy fatty acid with x carbon atoms, hydroxyl groups at atoms n and m; IS – internal standard

solvent extraction, as this provides extra information about the more complex compounds within the residue.

GC-MS analysis can rarely identify the exact source of an ancient, fatty residue as the processes of degradation and dissolution that occur during use and burial remove any compounds that are characteristic of particular fats (Evershed *et al.* 1997; Mottram *et al.* 1999; Evershed *et al.* 2002a; Evershed 2008a). Fats can be more closely identified by measuring the stable carbon isotope signatures of palmitic and stearic acids, the most common fatty acids (Evershed *et al.* 1994; Evershed *et al.* 1997; Evershed *et al.* 2002b; Evershed 2008a). This compound specific stable isotope analysis is carried out by GC-C-IRMS and requires a concentration of at least 1 nmole/μl of each compound to achieve a reliable result. Only two of the samples were available at the appropriate time and yielded a high enough concentration of palmitic and stearic acid to analyse by

GC-C-IRMS. These were extracted as above and methylated prior to GC-C-IRMS analysis by Professor Meier-Augenstein at Mylnefield Research Services, The James Hutton Institute, Invergowrie, Dundee, DD2 5DA. A detailed description of the methodology is in Appendix D.

Results and discussion

The samples can be divided into three groups on the basis of the results: those containing large amounts of fatty material; those yielding less fatty material but still considered fatty residues; and those containing no fat at all.

Samples containing large amounts of fatty material

Twenty-one of the 37 samples (1, 3, 8, 11, 12, 16, 17, 18, 24–30, 33–5, 37–9) from five cauldrons (1, 2, 3, 4, 5, 6 and 10) and two of the cauldron fragments (19 and 20) yielded high levels of fatty material (140 μg/g – 8mg/g) with a range of

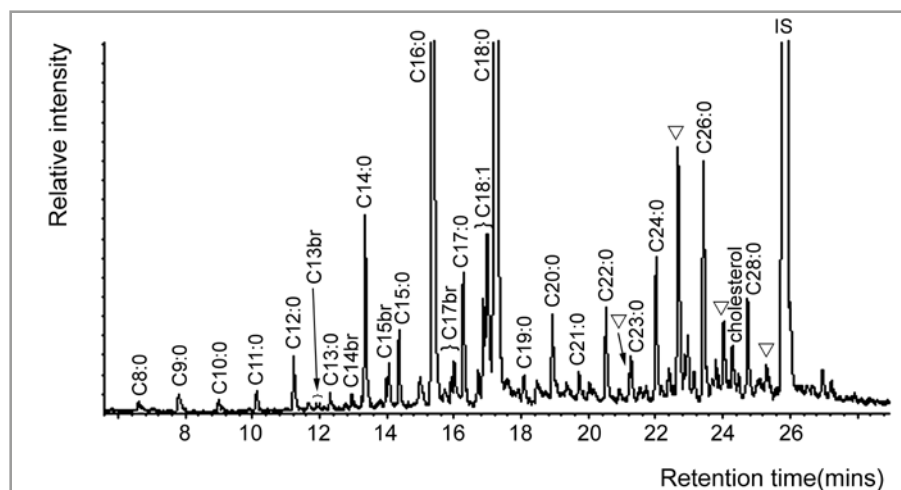


Figure 93 An enlargement of the chromatogram from sample 8 showing short-chain fatty acids. Key: Cx:y – fatty acid with x carbon atoms and y double bonds; ▽ – long-chain, even carbon numbered alcohol; IS – internal standard

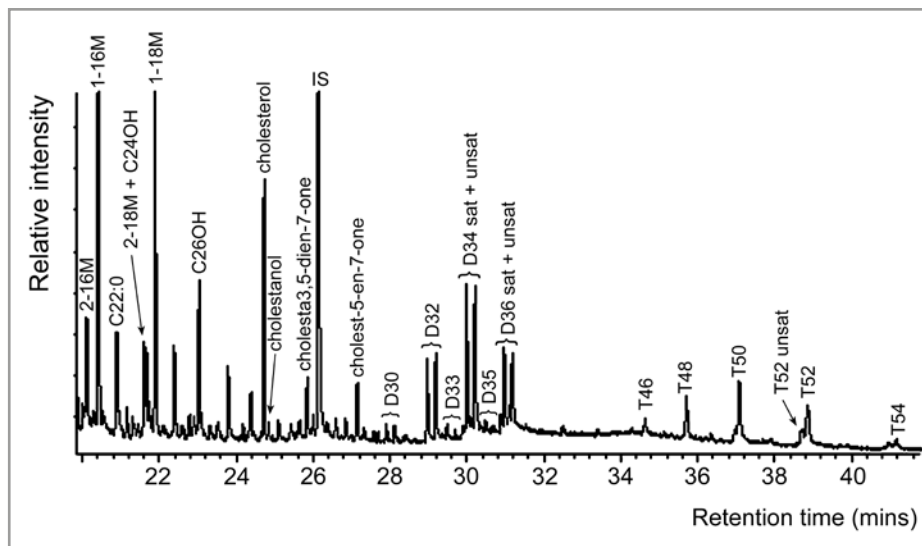


Figure 94 Partial chromatogram of sample 24 (solvent extract) showing the region between 21 and 41 minutes retention time. Key: y-xM – monoacylglycerol with x carbon atoms in the fatty acid moiety at position y on the glycerol backbone; Dx – diacylglycerol with x carbon atoms; Tx – triacylglycerol with x carbon atoms; sat + unsat – indicates that there are saturated and unsaturated fatty acids in the same molecule; unsat – an acylglycerol containing only unsaturated fatty acids; CxOH – alcohol with x carbon atoms; IS – internal standard

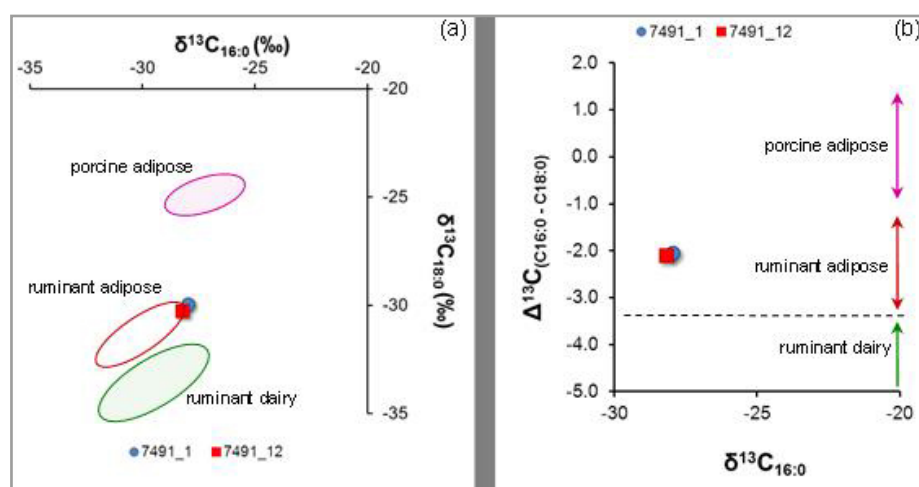


Figure 95 Isotopic results of GC-C-IRMS analysis of samples 7491_1 and 7491_12. a) results presented as a plot of the isotopic values of $C_{18:0}$ ($\delta^{13}C_{18:0}$) against $C_{16:0}$ ($\delta^{13}C_{16:0}$) measured per mil (‰), showing the generally accepted ranges for modern reference fats after (Copley *et al.*, 2005); b) plot of the difference between the values for $C_{18:0}$ and $C_{16:0}$ ($\Delta^{13}C = \delta^{13}C_{18:0} - \delta^{13}C_{16:0}$) against $C_{16:0}$. Data on ranges of values for modern reference fats from Copley *et al.* (2005)

saturated, straight-chain fatty acids between $C_{7:0}$ and $C_{22:0}$, dominated by palmitic ($C_{16:0}$) and stearic ($C_{18:0}$) acids (**Fig. 92a–b**) (Evershed 1993; Heron and Evershed 1993; Evershed 2008a). They also have features which are characteristic of animal fats (low unsaturates, cholesterol) (Padley *et al.* 1994; Gunstone 2004, 18–20), possibly ruminant body (adipose) fat (branched acids, especially $C_{17:0}$) (Evershed 1993; Gunstone 1994; Gunstone 2004, 18–20). Short-chain fatty acids in samples 8 and 24 (**Fig. 93**) may indicate the presence of ruminant milk fat in these samples, but is not conclusive (Dudd and Evershed 1998; Dudd *et al.* 1999; Gunstone 2004; Craig *et al.* 2005). Some samples contain compounds characteristic of heated fats such as ω -(*o*-alkylphenyl) fatty acids (12, 24, 25, 33, 38–9) (Dobson 1998; Hansel *et al.* 2004; Destailats and Angers 2005) and ketones (1) (Raven *et al.* 1997; Evershed 2008b). Solvent extracts of 12 of these samples (1, 3, 16, 24–7, 30, 33, 35, 38, 39) showed that these fats were relatively well preserved as acylglycerols (complex components of fresh fats) were present (**Fig. 94**). GC-C-IRMS of samples 1 and 12 showed that these two samples were within the generally accepted range for ruminant adipose fats (**Fig. 95**).

In addition to the fatty material ten samples (3, 16, 24, 25, 28, 33, 34, 35, 37, 39) yielded polyaromatic hydrocarbons (PAHs). These compounds form in heated/burnt organic material, although they can also be present in soils, dust, air

and groundwater (Simoneit 2002; Olsson 2006; Rogge *et al.* 2007; Micić *et al.* 2011) (**Fig. 96**). However, PAHs were not present in the soil samples, leading to the conclusion that they were integral to these residues.

All 21 samples also yielded a group of compounds including long-chain, even carbon-numbered alcohols (C_{20} – C_{32}); odd carbon-numbered alkanes (C_{23} – C_{35}) and long-chain fatty acids ($C_{22:0}$ – $C_{34:0}$) which are associated with the presence of plant waxes (Eglinton and Hamilton 1967; Heron *et al.* 1991; Bianchi 1995) (**Fig. 97**) and the identification of the plant sterol β -sitosterol in 1, 12, 24 and 35 support the presence of plant material. However, all these compounds are also present in soils and burnt biomass (Heron *et al.* 1991; Simoneit 2002; Otto and Simpson 2007; Rogge *et al.* 2007). These compounds are present in the soils at 50–70 $\mu\text{g/g}$, so soil could be the source of the same compounds in the samples. However, in six samples (1, 3, 8, 17, 18, 28), from cauldrons 1, 3 and 4, the compounds are present at higher concentrations than those found in soils (106 to 433 $\mu\text{g/g}$) and, in these samples at least, the presence of plant material is highly probable, although it is not possible to identify what kind of plant(s).

Samples containing lower levels of fatty material

Twelve samples (2, 4–7, 19, 20–2, 31, 32, 36) from cauldrons 2, 3, 4, 11 and 12 and from fragments 19 and 20 contained lower

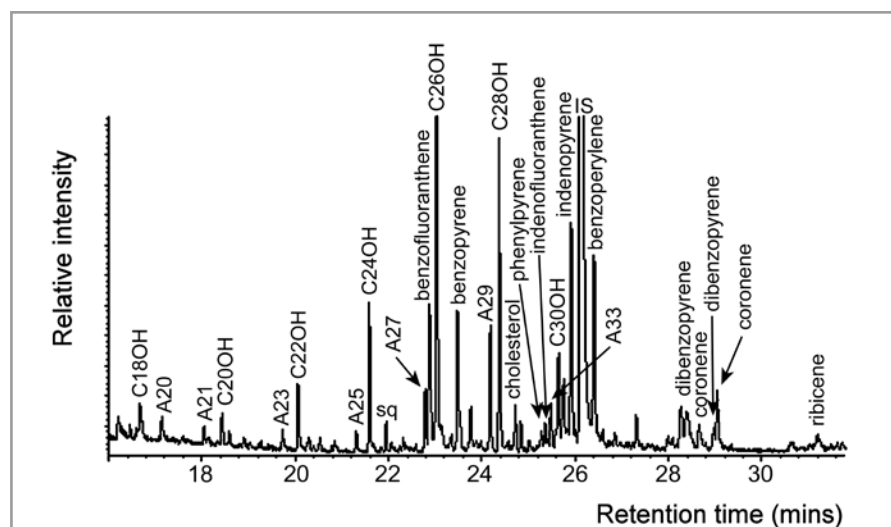


Figure 96 Partial chromatogram of the neutral fraction between 16 and 32 minutes of sample 28. Key: Cx:y – fatty acid with x carbon atoms and y double bonds; CxOH – alcohol with x carbon atoms; Ax – alkane with x carbon atoms; IS – internal standard

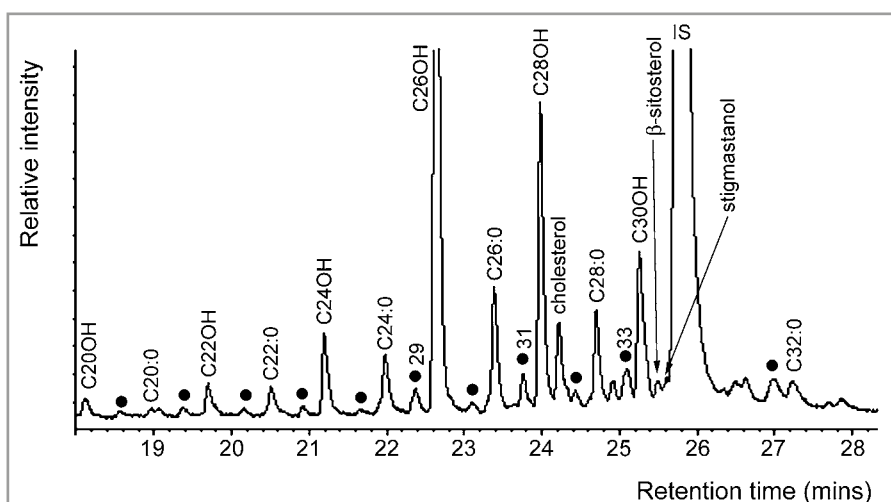


Figure 97 Enlargement of the portion of the chromatogram of sample 1 between 18 and 28 minutes showing compounds characteristic of plant materials. Key: Cx:y – fatty acid with x carbon atoms and y double bonds; CxOH – long-chain alcohol with x carbon atoms; • – n-alkane; •x – n-alkane with x carbon atoms; IS – internal standard

levels of degraded fat (17–100 µg/g) with few distinguishing features. Only three (2, 7, 20) yielded significant levels of plant-derived compounds and only two (22, 32) yielded PAHs.

Samples containing no fatty material

Four samples (9, 10, 13, 23) from four cauldrons (1, 4 and 10 and fragment 19) yielded no significant levels of fatty material. Three of these (9, 10 and 23) contained high levels of the plant-derived compounds (>90 µg/g). No PAHs were present. Sample 23 was also highly contaminated with unidentified material which is probably modern. All results are summarised in detail in **Table 11**.

Discussion

The residues from these cauldrons are extremely well preserved with all but four samples containing fatty material, and three of those four yielding high levels of plant material. Every cauldron and cauldron fragment yielded at least one residue which contained fatty material. This indicates that all the cauldrons sampled had been used prior to their deposition in the pit. Cauldrons 1, 2, 3, 4, 5, 6 and 10 all contained residues with evidence of heating of organic material (ketones and alkylphenyl fatty acids which form in heated fats and PAHs from generic organic material). Of the remaining four cauldrons, two (11 and 12) have only yielded

one sample each making it hard to get an overall picture of residues from these two cauldrons. The evidence of heated organic material indicates that most of the cauldrons were used for cooking, not just for the storage or serving of food.

There is evidence for the presence of plant material in four cauldrons (1, 3, 4 and 10, and fragment 20). Although there is no way to determine from the biomolecular results what plant material was present, macrobotanical evidence from the sediment around and inside the cauldrons revealed the presence of charred remains from barley, emmer wheat, spelt and peas (see Chapter 10); any of these would be consistent with the biomolecular results.

The results point to the use of the cauldrons for the cooking of fatty food and vegetables. This could have been in the form of a stew, gruel or broth containing both meat and vegetables or grains. The evidence can also be interpreted as the sum of residues from different individual uses of the vessel, for example, cooking meat stews and gruels containing grain on separate occasions. One sample each from cauldrons 3 and 4 identifies the fatty material as coming from ruminant body fat – indicating that meat from ruminant animals was the main contributor to the fat in these residues. The presence of two cattle skulls buried with the cauldrons is suggestive that the meat may have been beef, but there is no way to determine this from the biomolecular data. Although it was not possible to be as

Table 11 Summary of results from GCMS analysis

Laboratory sample no.	Cauldron no.	SF no.	Extraction procedure	Saturated fatty acids	Unsaturated fatty acids	Sterols	n-alkanes	Alcohols	Other compounds
7491_1	3	8	as	odd, even, branched C _{12:0} – C _{32:0}	C _{16:1} – C _{19:1} , e/o C _{18:1}	cholesterol, β -sitosterol, stigmastanol?	tr C24 – C33, o/e	even C18 – C30	tr ketones (odd, C31 – C35); mono- and di-hydroxy fatty acids; phytanic sugars?
7491_2	3	8	as	odd, even, branched, C _{12:0} – C _{34:0}	C _{16:1} – C _{19:1} , e/o	cholesterol, β -sitosterol	tr C23 – C35, o/e	even C16 – C32	phytanic; sugars?
7491_3	3	8	as	odd, even, branched C _{12:0} – C _{34:0}	C _{16:1} – C _{19:1} , e/o	cholesterol	tr C23 – C26, o/e	even C22 – C28	PAHs; phytanic; mono-hydroxy fatty acids
7491_4	19	16	as	C _{16:0} , C _{18:0} , tr C _{14:0} , C _{15:0} , C _{17:0}	tr C _{18:1}	nd	nd	tr C26 and C28	nd
7491_5	19	16	as	low levels odd, even, branched C _{14:0} – C _{24:0}	tr C _{18:1}	nd	nd	C26 and C28	nd
7491_6	4	9	as	odd, even, branched C _{14:0} – C _{28:0}	tr C _{18:1} and C _{19:1}	cholesterol?	nd	even C22 – C30	sugars?
7491_7	4	9	as	C _{16:0} , C _{18:0} , tr odd, even, branched C _{14:0} – C _{28:0}	traces C _{16:1} and C _{18:1}	cholesterol?	tr C29 – C31	even C22 – C30	phytanic; sugars?
7491_8	4	9	as	odd, even, branched C _{8:0} – C _{32:0}	C _{16:1} and C _{18:1}	cholesterol	traces C23 – C35	even C18 – C33	sugars?
7491_9	1	5	as	nd	nd	nd	nd	even C22 – C30	nd
7491_10	19	16	as	nd	nd	nd	traces C23 – C35	even C22 – C30	nd
7491_11	19	16	as	odd, even, branched C _{12:0} – C _{26:0}	C _{16:1} , C _{18:1} , C _{19:1}	cholesterol	nd	even C26 – C30	mono- and di-hydroxy fatty acids
7491_12	4	9	as	odd, even, branched C _{14:0} – C _{26:0}	C _{18:1}	cholesterol, cholesta-3, 5-dien-7-one, β -sitosterol	nd	tr even C24 – C28	phytanic; di-hydroxy fatty acid, C18-APFA
7491_13	4	9	as	nd	nd	nd	nd	tr C24 – C30	nd
7491_14 (soil)	4	9	as	tr odd, even, branched C _{12:0} – C _{32:0}	tr C _{18:1} and C _{19:1}	nd	tr odd C27 – C33	C20 – C32, e/o	tr phytanic acid, sugars, possible cyclic fatty acids
7491_15 (soil)	4	9	as	tr odd, even, branched C _{12:0} – C _{32:0}	tr C _{16:1} , C _{18:1} and C _{19:1}	tr cholesterol, β -sitosterol, other unidentified sterols	tr C22 – C35, o/e	even C18 – C32	phytanic; sugars
7491_16	2	7	as + se	odd, even, branched C _{14:0} – C _{24:0}	C _{18:1}	cholesterol	nd	tr C26	di-hydroxy fatty acid; benzopyrene
7491_17	4	9	as	C _{16:0} , C _{18:0} , low levels odd, even, branched C _{12:0} – C _{30:0}	tr C _{18:1}	cholesterol, cholestanol	tr odd C29 – C33	e/o C18 – C30	sugars?
7491_18	4	9	as	C _{16:0} , C _{18:0} , traces odd, even C _{12:0} – C _{28:0}	nd	nd	nd	even C26 – C30	DHA
7491_19	20	23	as	low levels C _{16:0} and C _{18:0}	nd	nd	nd	C26, C28	nd
7491_20	20	23	as	low levels C _{16:0} and C _{18:0} , traces odd, even, branched C _{12:0} – C _{28:0}	tr C _{18:1} and C _{19:1}	tr cholesterol and β -sitosterol	tr	e/o C18 – C30	tr sugars?
7491_21	2	7	as	low levels C _{16:0} and C _{18:0} , tr odd, even, branched C _{14:0} – C _{21:0}	nd	nd	nd	even C24 – C30	nd

Table 11 continued

Laboratory sample no.	Cauldron no.	SF no.	Extraction procedure	Saturated fatty acids	Unsaturated fatty acids	Sterols	n-alkanes	Alcohols	Other compounds
7491_22	2	7	as	odd, even, branched C _{12:0} – C _{22:0}	tr C _{18:1}	nd	nd	nd	PAHs, tr phytanic
7491_23	10	105	as	tr even C _{12:0} – C _{18:0}	nd	nd	odd C29 – C33	even C12 – C32	trimethyl-carboxyisopropyl-pentanoic acid, isobutyl ester; chloro-octadecane; fluorenone; anthracene; methyl dodecylbenzene; acyl-cyclohexane; homologous series unidentified compounds; other unidentified compounds; unresolved mixture
7491_24	10	105	as + se	odd, even, branched C _{7:0} – C _{28:0}	C _{18:1} , tr C _{16:1}	tr cholesterol and oxidation products, plant sterol	tr odd C29 and C31	tr even C24 – C30	tr phytanic; TMTD; oxo-fatty acids, mono- and di-hydroxy fatty acids; C18-APFAs; MAGs, DAGs, TAGs; tr PAHs
7491_25	10	105	as + se	odd, even, branched C _{8:0} – C _{26:0}	C _{18:1} , tr C _{16:1}	cholesterol and oxidation products	tr odd C29 – C33	tr even C24 – C30	tr phytanic; TMTD; oxo-fatty acids, mono- and di-hydroxy fatty acids; C18-APFAs; MAGs, DAGs; PAHs, sugars?
7491_26	10	105	as + se	odd, even, branched C _{8:0} – C _{32:0}	C _{18:1} , tr C _{16:1}	cholesterol	nd	tr even C26 – C30	tr TMTD; oxo-fatty acids; mono- and di-hydroxy fatty acids; C18-APFAs; MAGs, DAGs, TAGs
7491_27	1	5	as + se	odd, even, branched C _{7:0} – C _{26:0}	tr C _{18:1}	cholesterol, cholestadienone	tr odd C27 – C31	tr even C26 – C30	tr phytanic acid; tr C18-APFAs; MAGs, DAGs, tr DHA, tr anthracene
7491_28	1	5	as	odd, even, branched C _{7:0} – C _{28:0}	C _{18:1} , C _{16:1}	tr cholesterol	tr odd C25 – C35	even C18 – C30	PAHs; tr phytanic
7491_29	5	10	as	odd, even, branched C _{14:0} – C _{26:0}	C _{18:1}	nd	tr	tr even C22 – C30	nd
7491_30	5	10	as	odd, even, branched C _{12:0} – C _{30:0}	C _{16:1} , C _{18:1} , C _{19:1}	tr cholesterol	nd	tr even C24 – C28	tr phytanic; oxo-fatty acids; mono-hydroxy fatty acids; MAGs; traces sugars
7491_31	11	123	as	C _{16:0} & C _{18:0} , tr odd, even, branched C _{14:0} – C _{28:0}	C _{18:1}	nd	nd	tr even C22 – C30	nd
7491_32	2	7	as	low levels C _{16:0} and C _{18:0} , tr odd, even, branched C _{15:0} – C _{28:0}	C _{18:1}	nd	nd	tr even C24 – C30	PAHs; tr DHA

Laboratory sample no.	Cauldron no.	SF no.	Extraction procedure	Saturated fatty acids	Unsaturated fatty acids	Sterols	n-alkanes	Alcohols	Other compounds
7491_33	5 or 6	10 or 11	as	odd, even, branched C _{14:0} – C _{28:0}	C _{16:1} , C _{18:1} , C _{19:1}	cholesterol and oxidation products	nd	even C16 – C30	tr phytanic; oxo-fatty acids; mono-hydroxy fatty acids; C18-APFAs; PAHs; tr sugars
7491_34	2	7	as	odd, even, branched C _{12:0} – C _{28:0}	C _{16:1} , C _{18:1} , C _{19:1}	cholesterol and oxidation products	nd	even C18 – C28	tr phytanic; mono-hydroxy fatty acids; PAHs; tr sugars
7491_35	5 or 6	10 or 11	as	odd, even, branched C _{11:0} – C _{28:0}	C _{16:1} , C _{18:1} , C _{19:1}	cholesterol + oxidation products, β -sitosterol	nd	even C18 – C30	tr phytanic; tr TMTD; oxo-fatty acids; mono-hydroxy fatty acids; C18-APFAs; PAHs
7491_36	12	149	as	odd, even, branched C _{14:0} – C _{28:0}	C _{18:1}	tr cholesterol	nd	even C22 – C30	tr phytanic
7491_37	5	10	as	odd, even, branched C _{12:0} – C _{30:0}	C _{16:1} , C _{18:1} , C _{19:1} , C _{20:1}	tr cholesterol	nd	tr even C22 – C30	tr phytanic; oxo- and mono-hydroxy fatty acids; PAHs; tr sugars
7491_38	5	10	as	odd, even, branched C _{12:0} – C _{26:0}	C _{16:1} , C _{18:1} , C _{19:1} , C _{20:1}	low level cholesterol + traces oxidation products	nd	tr even C16 – C30	phytanic; tr TMTD; mono- and di-hydroxy fatty acids; C18-APFAs; tr PAHs; tr sugars
7491_39	5	10	as	odd, even, branched C _{12:0} – C _{26:0}	C _{16:1} , C _{18:1} , C _{19:1}	tr cholesterol	nd	nd	phytanic; tr TMTD; mono- and di-hydroxy fatty acids; C18-APFAs

Table 11 Summary of results from GCMS analysis. Key: Cx:y – fatty acid with x carbon atoms and y double bonds; Cx – chain with x carbon atoms; e/o – even numbered carbon chains more abundant than odd; TMTD – 4,8,12-trimethyltridecanoic acid; APFA – ω -(o-alkylphenyl) fatty acid; MAGs – monoacylglycerols; DAGs – diacylglycerols; TAGs – triacylglycerols; PAHs – polycyclic aromatic hydrocarbons; DHA – dehydroabiatic acid; tr – trace; nd – not detected; as – alkaline saponification; se – solvent extraction

specific about the fatty material in the other nine cauldrons and cauldron fragments, many of the residues do yield fatty material with the general characteristics of ruminant animal fat. However, without further isotopic analysis it is not possible to provide a definitive identification of these fats.

Three of the samples, 9, 23 and 10 from cauldrons 1 and 10 and fragment 19 respectively, contained no fat but did yield high levels of compounds associated with plant waxes. It is difficult to explain how these could have formed if the cauldrons had been used solely for the cooking of mixed meat and vegetable stews or broths. The presence of plant material alone suggests that these cauldrons had been used at some time for the cooking of vegetables or grains without meat, although this cannot be proved from the evidence available. Two of the samples (9 and 10) are from joints between the copper alloy sheets while 23 is from the interior of the copper alloy band from cauldron 10. As one of these samples is from the interior surface of a cauldron it appears that this is not a phenomenon restricted to residues from the riveted joints. In addition, the other samples from the joints contain fatty material, in some cases in very high abundances. Taking all this together, it seems unlikely that this is plant material used to pack out one of the joints, but

appears more indicative of food which seeped into the small cracks at the joints during cooking.

In general, there is little difference between residues from different parts of the cauldrons and most areas show all types of material in at least one sample. However, when comparing residues from different areas of the cauldrons it is possible to discern some small differences in the proportions of residues of different types. For example, all the residues from the iron bands or rims are very high in fat and contain no plant material. This may be due to a difference in preservation of the residues associated with iron substrates rather than copper alloy material. It could also be due to the natural accumulation of fatty material at the surface of boiling dishes such as stews, leading to larger fat deposits around the inner rims of vessels. Boiling or slopping of this food over the rim of a vessel can lead to similar deposits on the exterior of rims. However, there are only four samples associated with the iron bands, compared to 33 from copper alloy surfaces, and this is not enough to make this finding statistically significant.

A higher proportion (80%) of the exterior samples yielded PAHs when compared with the rest of the samples (45% of all samples taken together, and only 37% of non-exterior

samples), but this is not surprising as the exterior residues would have been consistently exposed to higher temperatures than the interior residues. They may also contain some sooty material from the burning fuel used to heat the cauldrons which is also rich in PAHs. In addition, there are only six samples from exterior surfaces, meaning that this finding is not statistically significant.

The most interesting phenomenon is the extremely good preservation of these residues. That the residues survived at all on the exposed surface of the metal shows that preservation in this context is good. This is probably due to their close contact with the metal surfaces, as both copper and iron can enhance the preservation of organic material (Sanford 1975; Watson 1988). Copper is a strong biocide, inhibiting the activity of microorganisms as corrosion products form and migrate away from the copper surface. Organic materials in contact with corroding copper can be preserved by complete encapsulation within a coating of copper salts, by impregnation of a porous material or by consolidation of the organic material as it is replaced by copper salts (Watson 1988). It was interesting to observe that many of the residues analysed have a pale greenish surface layer, a colour typical of copper carbonates which are the main corrosion products of copper and copper alloys. Iron oxides, which are the main corrosion products of iron, have been recorded as preserving organic material by replacement and impregnation (Watson 1988). Three of the five samples directly associated with the iron rims of the cauldrons (16, 33 and 39) contained reddish-brown areas very like rust in colour, and within the body of the residues rather than at the surface.

Conclusions

All cauldrons and both cauldron fragments yielded fatty material. Using isotopic analysis fatty material from cauldrons 3 and 4 was identified as ruminant animal fat. Many of the other samples yielded fat with similar characteristics and may also be ruminant fat but no exact identification can be made from the available evidence. The fatty material shows evidence of being cooked and confirms that the cauldrons were used before being deposited, probably to cook the meat from cow, sheep or goat. Given the presence of cattle skulls in the pit with the cauldrons it might appear that beef formed part of the final meal cooked in these vessels. Samples from cauldrons 1, 3, 4, 10 and fragment 23 probably contain plant material, which could have been cooked at the same time as the meat in a stew, or on separate occasions in a soup, porridge or gruel, depending on the type of plant.

There is no discernible difference between the residues from different sites in the cauldrons. Their preservation and composition seem unaffected by the substrate metal, whether they come from the riveted joints or the metal surfaces and whether they are from the base, sides or rim. In particular, there is no evidence of any material such as wax or resin being used to pack the riveted joints before use.

The residues are extremely well preserved and the fact that they are in close contact with the copper alloy or iron surfaces is probably a significant factor in this remarkable preservation.

Chapter 10

Wood and Macrobotanical Plant Remains Inside and Adhering to the Cauldrons

Caroline R. Cartwright and
Philippa Ryan

Following the lifting of the cauldrons and their transfer to the metals conservation laboratory at the British Museum, priorities for scientific investigation of the associated wood and other plant remains were established in consultation with the curator responsible for the material, Jody Joy. These included:

- Identification of the mineral-preserved wood and other plant remains found in the corrosion products on the surface of the iron or copper alloy of the cauldrons, in order to investigate whether wood might have been associated with the cauldron itself (such as a wooden lid or ladle), or represent a wooden (or straw) lining to the pit.
- Identification of the charred wood, charcoal and other charred plant remains from flotation of soil inside or very near the cauldrons. Such material might be evidence of the contents and/or the fuel associated with a feasting event. In addition, it was hoped that the seeds, grain and other macrobotanical remains might shed some light on the time of year when the cauldrons were deposited, or further information about the depositional context.

It should be noted that, at the time of writing, not all the cauldrons have been fully micro-excavated and conserved; consequently, in this chapter, we outline the scientific results thus far, but more samples may be processed and identified in the future as they become available.

Methods

Mineral-preserved wood, charred wood and charcoal

During the course of the conservation of each cauldron, for the mineral-preserved wood and other organic remains in situ on the cauldrons the conservators working on the material, Alexandra Baldwin and Jamie Hood, liaised systematically with Caroline Cartwright and a protocol for sampling was established. Given the range of preservation of the wood, charcoal and other plant remains, several different procedures and techniques were required to process, examine and identify all the categories of material.

For mineral-replaced pseudomorphs and casts of wood structure found on the cauldron fragments, scanning electron microscopy (SEM) was essential. Following standard procedures, because of the three-dimensional nature of wood and plant anatomy, transverse, radial longitudinal and tangential longitudinal (TS, RLS and TLS) sections need to be examined according to the international protocols of the International Association of Wood Anatomists (IAWA) (see Wheeler *et al.* 1989). However, in many of the cauldron samples, only one orientation was available (**Fig. 98**) and/or the anatomical features were incompletely preserved. Such samples, therefore, were not diagnostic even to genus level, let alone to species (see **Fig. 98**). This proved somewhat frustrating as many wood and other plant remains were clearly and visibly mineral-preserved on the cauldrons (**Fig. 99**), but if insufficient diagnostic anatomical criteria are discernible, secure identifications are not possible (also see Cartwright and Parkington 1997; Cartwright 2015).

Nonetheless, many examples (e.g. **Fig. 100**) were identifiable (see below in Results, **Table 12** and Appendix C). For both the mineral-preserved samples and the charred

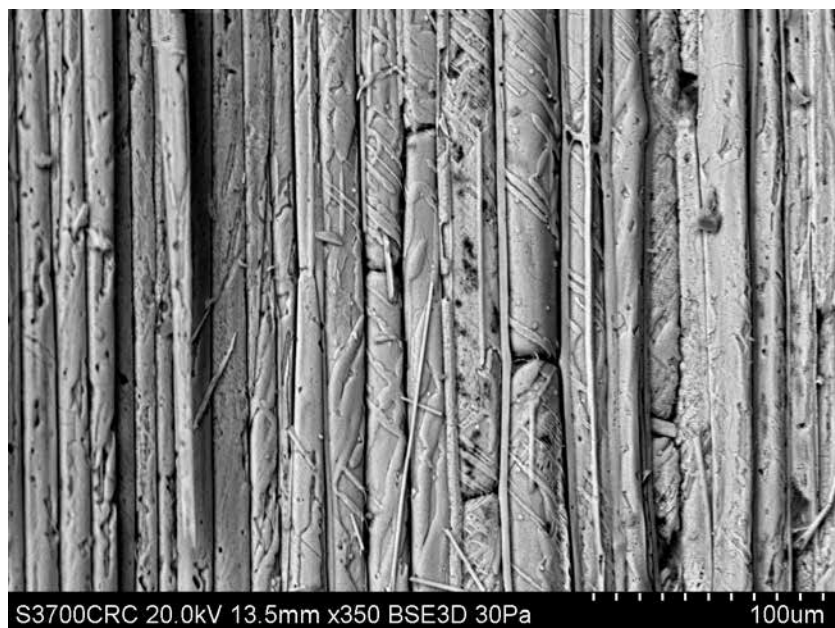


Figure 98 VP-SEM image of mineral-preserved wood in tangential longitudinal section (TLS) from vessel 2 fragment C; from soil close to Fe rim (image: C.R. Cartwright, British Museum)



Figure 99 VP-SEM image of mineral-preserved wood in TLS from vessel 2 fragment B; from Fe rim (image: C.R. Cartwright, British Museum)

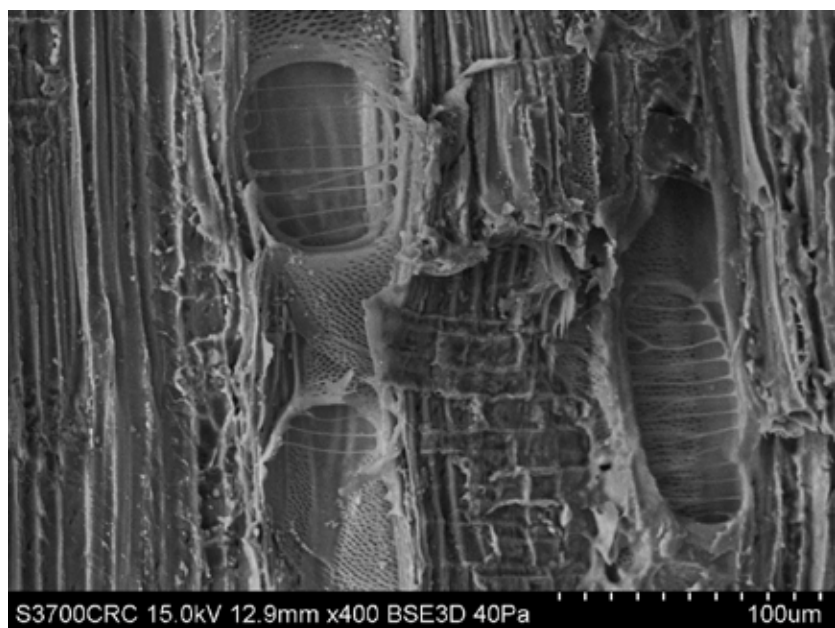


Figure 100 VP-SEM image of *Betula pendula* (silver birch) radial longitudinal section (RLS) from vessel 2 fragment D; from soil on the external surface of Fe rim fragment (image: C.R. Cartwright, British Museum)

Table 12 Charcoal and mineral-preserved organics (MP = mineral-preserved plant remains)

Cauldron no.	SF no.	Context no.	Type of organic material	Location where sample(s) taken	Identification(s)
2	7	101	charred wood	soil external surface of Fe rim fragment	<i>Fraxinus excelsior</i> , ash; <i>Corylus avellana</i> , hazel
2	7	101	mineral-preserved (MP) plant remains	soil external surface of Fe rim fragment	<i>Acer campestre</i> (field maple) and cereal straw (Poaceae family)
2	7	101	charred wood	soil external surface of Fe rim fragment	<i>Betula pendula</i> , birch; <i>Fraxinus excelsior</i> , ash
2	7	101	MP plant remains	soil external surface of Fe rim fragment	cereal straw (Poaceae family)
2	7	101	MP plant remains	soil external surface of Fe rim fragment	cereal straw (Poaceae family)
2	7	101	charred wood and nut fragment	soil external surface of Fe rim fragment	<i>Corylus avellana</i> (charred wood and charred hazelnut)
2	7	101	plant material (intrusive)	soil external surface of Fe rim fragment	modern rootlets and root hairs
2	7	101	charred wood	soil external surface of Fe rim fragment	<i>Fraxinus excelsior</i> , ash
2	7	101	charred wood	soil external surface of Fe rim fragment	<i>Fraxinus excelsior</i> , ash
2	7	101	MP wood and plant remains	corrosion from exterior of Fe rim	<i>Corylus avellana</i> , hazel; cereal straw (Poaceae family)
2	7	101	charred wood	soil external surface of Fe rim fragment	<i>Fraxinus excelsior</i> , ash; <i>Corylus avellana</i> , hazel
2	7	101	charred wood	soil external surface of Fe rim fragment	<i>Betula pendula</i> , birch; <i>Fraxinus excelsior</i> , ash
2	7	101	charred wood	in situ on fragment of corrosion from Fe rim	<i>Fraxinus excelsior</i> , ash
2	7	101	charred wood	soil external surface of Fe rim fragment	<i>Fraxinus excelsior</i> , ash
2	7	101	MP wood and plant remains	soil external surface of Fe rim fragment	<i>Corylus avellana</i> , hazel; cereal straw (Poaceae family)
2	7	101	MP plant remains	soil external surface of Fe rim fragment	<i>Fraxinus excelsior</i> , ash; <i>Corylus avellana</i> , hazel
2	7	101	charred wood	soil external surface of Fe rim fragment	<i>Fraxinus excelsior</i> , ash
2	7	101	charred plant remains	soil external surface of Fe rim fragment	<i>Corylus avellana</i> , hazel; cereal straw (Poaceae family)
2	7	101	MP wood and plant remains	corrosion from exterior of Fe rim	<i>Fraxinus excelsior</i> , ash; cereal straw (Poaceae family)
2	7	101	MP wood and plant remains	corrosion from exterior of Fe rim	<i>Acer campestre</i> (field maple) and cereal straw (Poaceae family)
2	7	101	charred wood	sieved soil around cauldron 2	<i>Fraxinus excelsior</i> , ash; cereal straw (Poaceae family)
2	7	101	charred plant remains	sieved soil around cauldron 2	<i>Fraxinus excelsior</i> , ash; cereal straw (Poaceae family)
19	16		charred plant remains	soil in interior of bowl; SF 16 from Block 9	<i>Acer campestre</i> (field maple) and cereal straw (Poaceae family)
1	5	125	MP wood and plant remains	corrosion from rim of vessel 1	<i>Fraxinus excelsior</i> , ash; cereal straw (Poaceae family)
1	5	125	charcoal	soil adjacent to rim of vessel 1	<i>Fraxinus excelsior</i> , ash; <i>Corylus avellana</i> , hazel
1	5	125	MP wood and plant remains	soil adjacent to rim of vessel 1	<i>Fraxinus excelsior</i> , ash; cereal straw (Poaceae family)
1	5	125	MP wood and plant remains	soil adjacent to rim of vessel 1	<i>Fraxinus excelsior</i> , ash; cereal straw (Poaceae family)
1	5	125	charcoal	soil adjacent to rim of vessel 1	<i>Fraxinus excelsior</i> , ash; <i>Corylus avellana</i> , hazel
1	5	125	charcoal	soil adjacent to rim of vessel 1	<i>Fraxinus excelsior</i> , ash; <i>Corylus avellana</i> , hazel

Table 12 continued

Cauldron no.	SF no.	Context no.	Type of organic material	Location where sample(s) taken	Identification(s)
1	5	125	charcoal	soil adjacent to rim of vessel 1	<i>Fraxinus excelsior</i> , ash; <i>Corylus avellana</i> , hazel
1	5	125	charcoal	soil adjacent to rim of vessel 1	<i>Fraxinus excelsior</i> , ash; <i>Corylus avellana</i> , hazel
1	5	125	charcoal	soil adjacent to rim of vessel 1	<i>Fraxinus excelsior</i> , ash; <i>Corylus avellana</i> , hazel
1	5	125	charcoal	soil adjacent to rim of vessel 1	<i>Betula pendula</i> , birch; <i>Fraxinus excelsior</i> , ash
4	9	125	charcoal	layer 7	<i>Betula pendula</i> , birch
4	9	101	charcoal	soil adjacent to fragment	<i>Betula pendula</i> , birch
4	9	101	MP wood and plant remains	layer 2, S side	<i>Corylus avellana</i> , hazel; cereal straw (Poaceae family)
4	9	161	MP wood and plant remains	soil fill of cauldron 4	<i>Fraxinus excelsior</i> , ash; cereal straw (Poaceae family)
4	9	161	charcoal	soil fill of cauldron 4, SE side	<i>Fraxinus excelsior</i> , ash; <i>Corylus avellana</i> , hazel
4	9	101	MP wood and plant remains	soil adjacent to rim S side	<i>Fraxinus excelsior</i> , ash; cereal straw (Poaceae family)
4	9	101	MP wood and plant remains	soil adjacent to rim, S side	<i>Fraxinus excelsior</i> , ash; cereal straw (Poaceae family)
4	9	101	MP wood and plant remains	soil adjacent to rim, S side	<i>Corylus avellana</i> , hazel; cereal straw (Poaceae family)
4	9	101	MP wood and plant remains	soil adjacent to rim, S side	<i>Corylus avellana</i> , hazel; cereal straw (Poaceae family)
4	9	125	charcoal	soil from bottom of block, NE side	<i>Fraxinus excelsior</i> , ash
4	9	101	charcoal	from soil around handle, S side	<i>Fraxinus excelsior</i> , ash
4	9	161	charcoal	inside rim layer 4, S side	<i>Fraxinus excelsior</i> , ash
4	9	161	charcoal	block layer 4, SE side	<i>Fraxinus excelsior</i> , ash
4	9	161	charcoal	fill of cauldron 4	<i>Fraxinus excelsior</i> , ash
4	9	161	charcoal	block layer 5 middle	<i>Fraxinus excelsior</i> , ash
1	5	101	charcoal	soil close to Fe	<i>Fraxinus excelsior</i> , ash
1	5	101	charcoal	soil close to Fe	<i>Fraxinus excelsior</i> , ash
1	5	101	MP wood and plant remains	soil close to Fe	<i>Acer campestre</i> (field maple) and cereal straw (Poaceae family)
1	5	101	MP wood and plant remains	soil close to Fe	<i>Corylus avellana</i> , hazel; cereal straw (Poaceae family)
1	5	101	charred wood	soil close to Fe	<i>Fraxinus excelsior</i> , ash
1	5	101	charcoal	soil close to Fe	<i>Fraxinus excelsior</i> , ash
1	5	101	charcoal	soil close to Fe	<i>Fraxinus excelsior</i> , ash
1	5	101	MP wood and plant remains	soil close to Fe	<i>Fraxinus excelsior</i> , ash; cereal straw (Poaceae family)
1	5	101	charcoal	soil close to Fe	<i>Fraxinus excelsior</i> , ash
1	5	101	MP wood and plant remains	soil close to Fe	<i>Fraxinus excelsior</i> , ash; cereal straw (Poaceae family)
1	5	101	charcoal	soil close to Fe	<i>Fraxinus excelsior</i> , ash
1	5	101	MP wood and plant remains	soil close to Fe	<i>Fraxinus excelsior</i> , ash; cereal straw (Poaceae family)
1	5	101	MP wood and plant remains	from rim	<i>Fraxinus excelsior</i> , ash; cereal straw (Poaceae family)
1	5	101	charcoal	soil next to Fe rim	<i>Fraxinus excelsior</i> , ash
1	5	101	charcoal	soil next to Fe rim	<i>Fraxinus excelsior</i> , ash

Cauldron no.	SF no.	Context no.	Type of organic material	Location where sample(s) taken	Identification(s)
1	5	101	MP wood and plant remains	soil next to Fe rim	<i>Fraxinus excelsior</i> , ash; cereal straw (Poaceae family)
1	5	101	MP wood and plant remains	from rim	<i>Fraxinus excelsior</i> , ash; cereal straw (Poaceae family)
1	5		MP wood and plant remains	?	<i>Acer campestre</i> (field maple) and cereal straw (Poaceae family)
10	105	101	MP wood and plant remains	rim	<i>Fraxinus excelsior</i> , ash; cereal straw (Poaceae family)
10	105	101	charcoal	soil close to Fe rim outside cauldron	<i>Fraxinus excelsior</i> , ash
10	105	101	charcoal	soil outside vessel	<i>Fraxinus excelsior</i> , ash
10	105	101	MP wood and plant remains	close to Fe rim	<i>Fraxinus excelsior</i> , ash; cereal straw (Poaceae family)
10	105	101	MP wood and plant remains	from Fe rim	<i>Fraxinus excelsior</i> , ash; cereal straw (Poaceae family)
10	105	101	charcoal	soil from round vessel, W side	<i>Betula pendula</i> , birch; <i>Fraxinus excelsior</i> , ash
11	123	101	charcoal	soil around cauldron close to rim, N side	<i>Fraxinus excelsior</i> , ash
11	123	101	charcoal	close to Fe rim	<i>Fraxinus excelsior</i> , ash
11	123	101	MP wood and plant remains	from Fe rim	<i>Fraxinus excelsior</i> , ash; cereal straw (Poaceae family)
11	123		charcoal	soil outside vessel	<i>Fraxinus excelsior</i> , ash
11	123	101	MP wood and plant remains	soil from around cauldron 11	<i>Fraxinus excelsior</i> , ash; cereal straw (Poaceae family)
11	123	101	charcoal	soil from around cauldron 11	<i>Betula pendula</i> , birch; <i>Fraxinus excelsior</i> , ash
11	123	101	MP wood and plant remains	soil from around cauldron 11	<i>Acer campestre</i> (field maple) and cereal straw (Poaceae family)
9	121		MP wood and plant remains	interior of hollow rim	<i>Fraxinus excelsior</i> , ash; cereal straw (Poaceae family)
	95		MP wood and plant remains	in soil close to SF 95	<i>Fraxinus excelsior</i> , ash; cereal straw (Poaceae family)
8	82		MP wood and plant remains	soil exterior SW section of cauldron 8	<i>Fraxinus excelsior</i> , ash; cereal straw (Poaceae family)
3	8		charcoal	from flotation	<i>Fraxinus excelsior</i> , ash
	67		charcoal	from flotation	<i>Fraxinus excelsior</i> , ash
9	87		charcoal	from flotation	<i>Fraxinus excelsior</i> , ash

Table 12 Charcoal and mineral-preserved organics (MP = mineral-preserved plant remains)

material, the application of SEM rather than light (or optical) microscopy enabled illustration of a better depth of field in the preserved cell structure, as well as having the facility to offer high-magnification imaging where appropriate. Where possible each sample (irrespective of size) was oriented or fractured manually to show TS, RLS and TLS for examination, mounted on an aluminium SEM stub and examined uncoated in the Hitachi S-3700N variable pressure (VP) SEM, mostly with an accelerating voltage of 20kV. Occasionally this was lowered to 15kV, depending on the condition of the fragment. For optimal visualisation of diagnostic cellular detail, the working distance varied from 13.2mm to 18.3mm, as dictated by the individual specimen being examined. The chamber

pressure (whose unit of measurement is indicated by Pa, being the abbreviation for Pascal) also varied according to the state of preservation of each fragment. Most were imaged using VP, with 30 Pa chamber pressure, which was used to eliminate surface charging on non-conducting samples. Reference collection specimens of wood and charcoal were consulted, in addition to wood databases (InsideWood 2004; Wheeler 2011).

Charred seeds, grain and other plant macro-remains

Sediments were removed from the inside of cauldrons 3, 4, 9, 10 and 11 in the conservation laboratory by Alexandra Baldwin and Jamie Hood for processing by Philippa Ryan to retrieve charred macrobotanical remains (seeds, grains, nuts

and legumes). The samples were processed by simple bucket flotation. Flotation works upon the principle that charred remains will float to the surface when sediments are immersed in water. As the flotation processes were carried out in the winter, they were undertaken in laboratory conditions. Sediments were placed in a bucket, water added using a small hose and charred macro-remains were funnelled off and caught in a 0.5mm sieve. The floated fraction was then retained and dried for later analysis. A 1mm mesh within the bucket retained the heavy residue fraction, which was subsequently dried and scanned for any bones, pottery or aggregations of non-floating charred materials. Some clay-rich sediments, particularly from cauldron 3, were very compacted and required immersion in water for several hours prior to flotation, while other sediments easily disaggregated upon contact with water. The heavy residue fraction was sorted by eye, and a Leica MZ APO stereomicroscope was used for sorting and identifying the charred items in the flot between $\times 6$ to $\times 60$ magnifications.

Results

Mineral-preserved wood, charred wood and charcoal

Table 12 summarises the results of the identification of mineral-preserved wood and other plant remains, charred wood (i.e. partially burnt) and charcoal. Appendix C provides details of the anatomical features of each of the four woods.

Fragments were not counted; for this dataset such a practice would be meaningless, simply giving an index of fragmentation not a quantitative or semi-quantitative indicator of (relative) ubiquity of different taxa. In terms of samples examined, *Fraxinus excelsior*, ash, is most frequently present – both for mineral-preserved and charred wood. Other woodland trees, *Corylus avellana*, hazel, *Betula pendula*, silver birch and *Acer campestre*, field maple, also show a strong presence. It is noteworthy that most of these woody taxa (whether in mineral-preserved or charred condition) appear to be accompanied by cereal straw (also see discussion below). **Table 12** records one example of the presence of intrusive modern rootlets and root hairs, but it is evident that such material can be found in every cauldron.

Charred seeds, grain and other plant macro-remains

Charred plants recovered include cereal grains, cereal chaff and weed seeds (**Table 13**). Most of the grains were from hulled barley (*Hordeum vulgare*), followed by spelt (*Triticum spelta*). There was, however, a much higher proportion of chaff from spelt wheat than from barley. The wheat chaff was present mostly in the form of glume bases rather than spikelet forks. Pea and hazelnut fragments were also present. Common arable weed seeds included bedstraw (*Galium* sp.), mallow (*Malva* sp.), knotweeds, docks and sorrels (Polygonaceae family), goosefoot/fat hen and orache (Amaranthaceae family) and wild grasses (Poaceae family). Most of the larger wild grasses were identified as *Bromus hordeaceus* type (brome).

Discussion

Mineral-preserved wood, charred wood and charcoal

Mineral-preserved organic material was present in large quantities on the iron sections of the majority of cauldrons within the pit (see Chapter 7 and the Catalogue). Mineral-preserved wood and cereal straw was present in varying quantities on the six cauldrons from which samples were taken and positive identifications made. On all six cauldrons *Fraxinus excelsior*, ash wood was present in contact with the exterior of the iron rims and it was found within the interior of vessel 4. Additionally, *Corylus avellana*, hazel was found in conjunction with vessels 1, 2 and 4, which were all adjacent to each other within the western half of the pit. *Acer campestre* (field maple) was identified preserved in relation to vessels 1, 2 and 11. Mineralised wood remains on the cauldron rims may be indicative of a wooden lid or ladle, although it is not clear if wooden lids or ladles were used with such cauldrons. Ash wood would have been an excellent choice for either, as its properties make it a good-quality, tough, all-purpose timber. Ash would function equally well, however, as a wooden bucket or even as a substantial pit lining to protect the cauldrons. It is possible that the sustained presence of ash in the Chiseldon charcoal record too (see **Table 12**) is indicative of its value as fuel. Hazel, apart from producing edible nuts, was important in the past as a source of flexible timber, useful for hurdles, stakes and thatching spars. It also yields useful firewood.

Betula pendula (silver birch) and *Acer campestre* (field maple), often found at woodland edges, have long histories of rural and domestic use. Birch timber is light but strong and has been selected for cart-making, ploughs and furniture, as well as for gates, fences and broomsticks. Birch bark has a variety of utilitarian, dietary and medicinal applications, and birch sap was (and still is) used for making wine. Birch timber lends itself well for preferential selection as firewood; due to its high calorific value, it will burn well despite being wet, freshly cut or even frozen. Field maple wood is fine-grained, split-resistant, elastic and tough. As it takes a high polish, its decorative qualities are best displayed in small objects such as cups and bowls. It also provides excellent charcoal for hearths and fires. As with all maples, the tree sap can be used for making wine or syrups.

Charred seeds, grain and other plant macro-remains

The charred remains described in **Table 13** are typical of assemblages deriving from domestic waste, and the cereal de-husking waste suggests this process occurred in the local vicinity of the Chiseldon cauldron pit. The charred remains contain cereal grains that may derive from food spilled during the process of cooking, as well as residues of crop cleaning by-products that may have been disposed of as rubbish, or deliberately used as fuel. The high proportions of weed seeds and crop-processing debris suggest only partial cleaning of cereal crops prior to storage.

De-husking of glume wheats (the removal of the seed bracts encasing the grain) is usually interpreted as a small-scale day-to-day process. Glume wheats would generally have been stored in spikelet form thus requiring de-husking prior to consumption (in these cereal varieties spikelets

IDENTIFICATIONS OF PLANTS PRESENT		SAMPLE CONTEXTS Cauldron number					
		10	11	9	3	4	TOTAL
Litres processed		4.5	2	2.5	40	23	69
Flotation (flot) volumes		16ml	2ml	4ml	68ml	40ml	137ml
<i>Triticum spelta</i>	spelt grains		1	1	26	12	40
<i>Triticum spelta</i>	spelt spikelet fork	1	2		2	4	9
<i>Triticum spelta</i>	spelt glume bases	11	6	1	52	60	130
<i>Hordeum</i> sp.	barley grains	5		2	14	32	53
<i>Hordeum</i> sp.	barley tail grains				3		3
<i>Hordeum</i> sp.	barley rachis	2			12	4	18
cereals	indeterminate cereal grains		4	2	20	27	53
cf. <i>Avena</i>	oat				1		1
<i>Bromus secalinus</i> / <i>hordeaceus</i>	brome grasses	3			42	25	70
<i>Bromus</i> sp.	brome grasses	3	2	3	2	6	16
<i>Bromus</i> sp. (fragments)	brome grasses	5			8	26	39
<i>Festuca</i> sp.	fescue	2			4	6	12
Poaceae indet.	indeterminate small wild grasses	4	2		42	21	69
<i>Atriplex</i> sp.	orache	1			5	1	7
<i>Polygonum</i> sp.	knotgrass				2	1	3
<i>Silene</i> sp.	catchfly				3	1	4
<i>Papaver</i> sp.	poppy					2	2
<i>Rumex</i> sp.	dock	1	1	1	19	15	37
<i>Taraxacum officinale</i>	dandelion	4			14	11	29
<i>Galium</i> sp.	bedstraw	2			1	1	4
small Fabaceae indet.	indeterminate small legumes				4		4
<i>Pisum sativum</i>	pea	1				3	4
<i>Corylus</i> sp. nutshell fragments	hazelnut				1		1
<i>Cyperus</i> sp.	sedge				1		1
Cyperaceae	sedge family	1					1
<i>Centaurea</i> sp.	thistle			1			1
<i>Chenopodium album</i>	fat hen					2	2
<i>Ranunculus</i> sp.	buttercup					2	2
<i>Malva</i> sp.	mallow					2	2
Polygonaceae indet.	knotweeds					2	2
Indeterminate		6	2	3	30	39	80

Table 13 Charred seeds and grains

remain intact post threshing in contrast to free-threshing types). On the other hand, barley rachises are often separated at an early stage of crop processing away from a settlement site. Thus, where present in archaeological contexts, they may be interpreted as having been collected up specifically for use as fuel. Alternatively, if barley had been stored in ear form, the barley rachises would also be present in archaeological contexts. It follows, therefore, that if wheat and barley were stored in whole ear form, then crop-processing detritus reflects processing activities at that same location.

Thus, while potentially associated with specific feasting events, this evidence is not inherently diagnostic of these,

and may also derive from more day-to-day food preparation. Both scenarios are possible should evidence for a possible nearby settlement emerge in due course. Charred remains including seeds were also found in the sediments surrounding the cauldrons (see Stevens, Chapter 7).

The presence of both emmer and spelt is recorded in other Iron Age assemblages (e.g. Jones and Nye 1991; Draper 2004). During the Iron Age in Wiltshire, one might expect a great diversity of plants to have been cultivated and, in addition to spelt and emmer, there would have been oats, barley and rye. Use was also made of beans, peas, vetch, sorrels and fat hen. At Chiseldon, however, the size of the assemblage is too small to situate the ratios of cereals present

within any meaningful temporal scenario in terms of crop change (such as one might expect for a settlement assemblage) or to place it within the framework of reference of agricultural production and consumption for the British Iron Age proposed by Van der Veen and Jones (2006). This is tantalising, as Van der Veen and Jones (2006) postulate that grain storage pits in hillforts may well have been used for communal feasts (also see Van der Veen 2007) (Chapter 12).

Conclusions

Given that we know that the Chiseldon cauldrons are large vessels that could accommodate much liquid or food, it is reasonable to suppose that they were not used every day for domestic meals, but rather for communal events such as feasting. In consequence, one of the primary objectives of the scientific analyses was to identify any possible plant remains which could represent feasting foods, i.e. as cauldron contents. However, the macrobotanical evidence (see above) is open to more than one interpretation; the cereals and other seeds could have formed part of a feast, but could also be representative of the daily domestic meal. The crop-processing waste is similarly equivocal; it might be evidence of deliberate use as pit lining material, and also for

fuel, and/or it may testify to nearby crop-processing activities and grain storage within a settlement. Although it was hoped that the seeds, grain and other macrobotanical remains might shed some light on the time of year when the cauldrons were deposited, the quantity of material available for analysis is too small to speculate further.

The other primary objective of the current scientific analyses was to establish, through identification of mineral-replaced wood, charred wood and charcoal, whether the Chiseldon cauldron pit originally contained, or was made up of, perishable organic material. The evidence (see above), while not unequivocal, does indicate that it is possible that the pit was wood-lined and that cereal straw may have been used as packing material or lining as well. All the woods present – ash, hazel, birch and field maple – not only yield useful all-purpose timber, but also provide an excellent source of charcoal for fuel/firewood for feasting events (as well as in routine domestic ones). These trees offer other useful products, including edible nuts, sap and bark. One cannot attest to the presence of a wooden lid or ladle, drinking vessels, bowls, buckets or other feasting utensils, but their presence cannot be excluded.

Chapter 11

Dating the Cauldron Pit

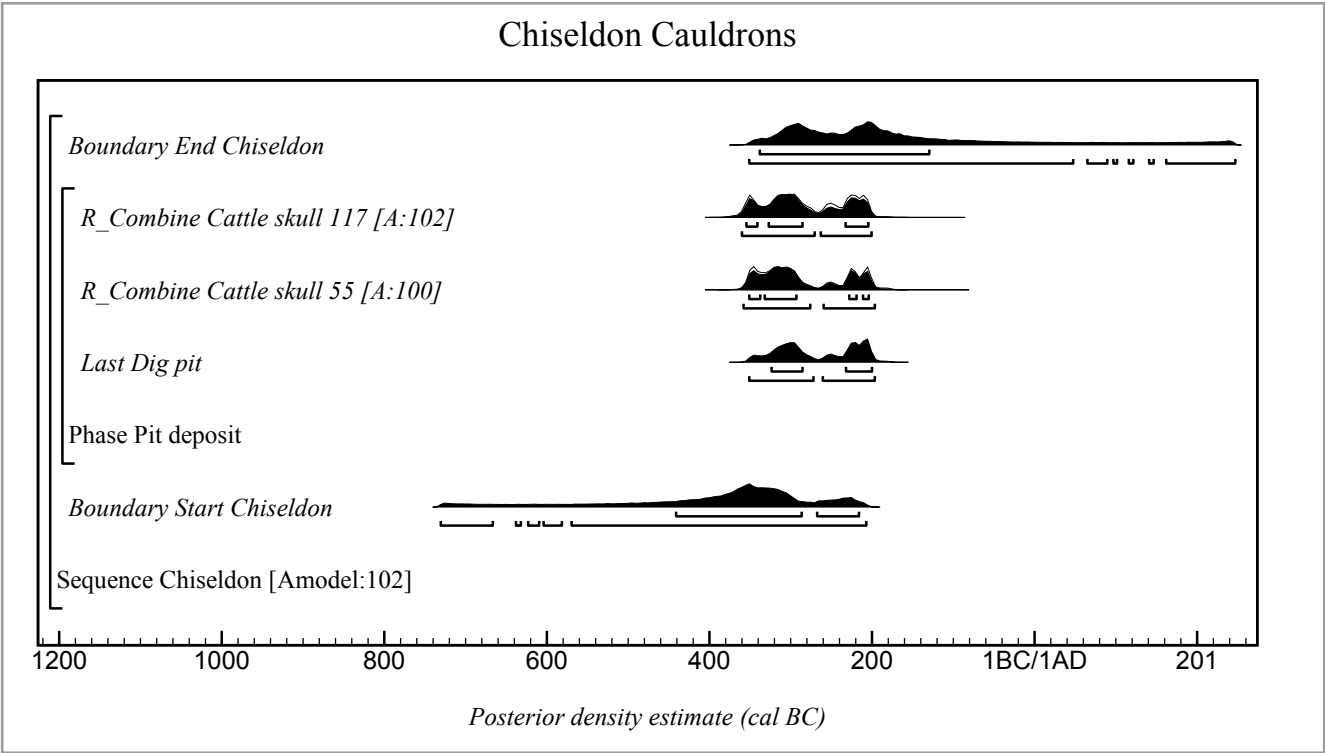
Alistair J. Barclay and
Michael J. Grant

Four samples of bone from two cattle skulls were submitted to the Scottish Universities Environmental Research Centre, East Kilbride (SUERC) for radiocarbon dating using high precision measurement. The resulting measurements (**Table 14**) are calibrated against the IntCalog Northern Hemisphere radiocarbon curve (Reimer *et al.* 2009) using the program OxCal 4.1 (Bronk Ramsey 1995; 2001; 2009). The calibrated date is quoted as calibrated years BC, with date ranges quoted using the 2 σ calibrated range (95.4%) and end point rounded outwards to 5 years (Bayliss *et al.* 2008). All stable isotope values are within the standard ranges. The C:N ratio values indicate good collagen preservation.

The objective was to determine the date of two cattle skulls. These may have been displayed but were still in a relatively fresh condition, suggesting that the period between butchery, display and burial could have been relatively short (within a few months or years) (Higbee, Chapter 7). The date for the skulls is therefore assumed to be close to that of the digging of the pit. Replicate measurements were obtained on samples from the two skulls (55a–b: SUERC-45221 and 45222, and 117a–b: SUERC-45223 and 45224). Each set of measurements produced statistically consistent results (see **Table 14**). In addition, all four age determinations are statistically consistent ($T'=1.7$; $v=3$; $T'(5\%)=7.8$) supporting the likelihood that they could be from a single short event. The two measurements have been combined using the OxCal *R_Combine* function to produce a weighted mean prior to calibration. The two combined dates have been modelled to produce a date estimate for the digging of the pit and the placing of the deposit (**Fig. 101**).

Given Higbee’s suggestion (Chapter 7) that the skulls were probably not displayed for a long period of time, then the

Figure 101 Date estimate for the digging of pit 133 and the placing of the deposit



Laboratory code	SF no.	Material identification (sample size in grams)	Radiocarbon age (BP)	$\delta^{13}\text{C}$ (‰)	$\delta^{15}\text{N}$ (‰)	C:N ratio	Calibrated date range (95.4% confidence cal BC)	X ² test	Posterior density estimate 95%
SUERC-45221	55a	Cattle skull (5g)	2197±22	-21.9	3.60	3.3	360 (62.5%) 275 260 (32.9%) 195	T'=0.2; v=1; T'(5%)= 3.8	360–270 cal BC (64.4%) 260–190 cal BC (31.0%)
SUERC-45222	55b	Cattle skull (5g)	2184±22	-21.7	3.60	3.3			
SUERC-45223	117a	Cattle skull (5g)	2184±23	-22.4	6.20	3.3	365 (57.1%) 270 265 (38.3%) 200	T'=1; v=1.3; T'(5%)= 3.8	370–270 cal BC (61.2%) 270–200 cal BC (34.2%)
SUERC-45224	117b	Cattle skull (6g)	2223±25	-22.4	6.30	3.3			

Table 14 Radiocarbon dating results

assumption is made that the younger of the two dated skulls will be close to the date of the act of burial. In the model presented in **Figure 101**, the OxCal *Last* function has been used to calculate the likely last event from the group of results. Therefore, the model provides an estimate for the event of burial (the digging of the pit and the placing of the deposit) rather than simply the date of the skulls.

Overall this model has good agreement ($A_{\text{model}}:102$). The digging of the pit has been modelled as 355–270 cal BC

(50.6%) or 265–195 cal BC (44.4%) (95.4% probability: see **Fig. 101**: Last: Dig pit). It is therefore likely that the deposit was made at some point during the later 4th to early 3rd century cal BC or the later 3rd century cal BC. If, as suggested below, the cauldrons were in use for up to 50 years, then the assumption can be made that they are also probably of 4th- or 3rd-century cal BC date.

Chapter 12

The Chiseldon Cauldrons in Context

Jody Joy

With contributions by A.P.
Fitzpatrick and Alexandra Baldwin

The Chiseldon hoard is unique. Nowhere else have so many complete Iron Age cauldrons been discovered from a single, well-excavated context. As was outlined in the Introduction to this volume, this provided the unparalleled opportunity to examine in detail the technology and manufacture of a sizeable number of contemporary objects. In this chapter we consider the significance of the cauldrons and questions arising from the scientific study and the analyses of the remains from the hoard, especially given the unexpectedly early radiocarbon dates, dating its deposition to the 4th or 3rd centuries BC, and the surprising presence of decorated objects. It is argued that owing to their large size and complicated manufacture, the cauldrons were especially made for the preparation and serving of food at feasts (Joy 2014) and the Chiseldon hoard symbolically represented a single feasting event, or series of events. The number of cauldrons in the hoard and their large combined capacity provides evidence for large social gatherings during the Middle Iron Age. As social hierarchies at this time are thought to have been relatively flat, the presence of cauldrons of sophisticated manufacture also demonstrates that complicated metalwork was not exclusively made for and used by elites as is sometimes assumed: the cauldrons are characteristic of a ritual mode of production. Building to this conclusion, we will begin by examining the cauldrons in more detail before considering the deposition of the hoard.

The Chiseldon cauldrons in context

The Chiseldon cauldrons belong to a long tradition of prehistoric cauldron manufacture. Two broad categories have been identified based on their technology and their production date (Gerloff 2010; Joy 2014). So-called 'Atlantic' cauldrons date to the Late Bronze Age and Earliest Iron Age and were comprehensively catalogued and studied by Gerloff (2010). Atlantic cauldrons are made of multiple sections of sheet copper alloy riveted together. They are constructed in layers, with upper layers attached to the inside of the layer below. Copper alloy ring handles are attached at or near the rim, which project outwards. Iron Age or Early Roman (IA/ER) cauldrons, on the other hand, date from the 4th century BC to the 2nd century AD (Joy 2014) and comprise both iron and copper alloy components. They typically consist of a large copper alloy bowl, copper alloy and/or iron bands, and an iron rim with two large iron ring handles and often have large capacities (**Fig. 102**).

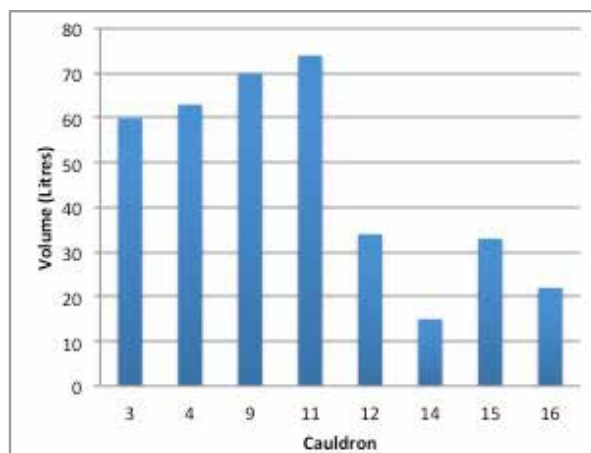


Figure 102 Volume of the Chiseldon cauldrons in litres

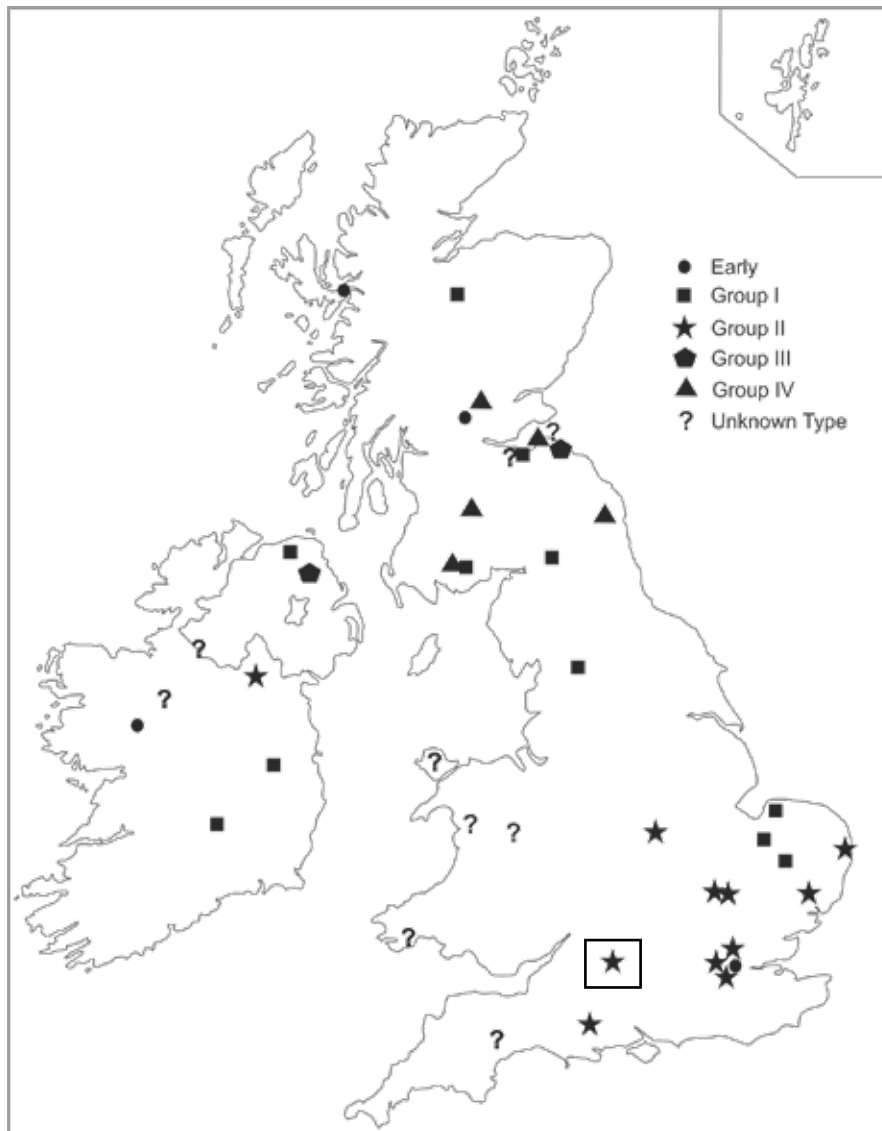


Figure 103 Distribution of IA/ER cauldrons in Britain and Ireland (the site of Chiseldon is indicated by the blue box)

Iron Age and Early Roman cauldrons

Including the finds from Chiseldon, over 60 IA/ER cauldrons from around 40 separate contexts are known in Britain and Ireland (Joy 2014, app. b) (**Fig. 103**). The finds from Chiseldon, therefore, represent approximately 25% of all the known examples of the IA/ER group from Britain and Ireland. The typology, recently reviewed by Joy (2014), comprises two broad types: ‘projecting-bellied’ and ‘globular’ or ‘straight-sided’ cauldrons (**Fig. 104**). Projecting-bellied cauldrons have a northerly geographical distribution (see **Fig. 103**) and date from the mid-1st to the 2nd century AD). Globular or straight-sided cauldrons are subdivided into three groups (**Fig. 105**). Overall, they are widely spread throughout the British Isles but each group possesses its own distinct regional distribution. The majority of the globular or straight-sided cauldrons date to the 2nd and 1st centuries BC (Stead and Rigby 1986, 60–1; Moss-Eccardt 1988, 88) but the dating evidence from Chiseldon has pushed their dating back to the 4th century BC (Joy 2014, 335; this volume, Chapter 11). This is important because it demonstrates that, as on the Continent (e.g. Vouga 1923; Jacobi 1974), cauldrons were in use in Britain during the Middle Iron Age. The dating of the Chiseldon group back possibly as far as the 4th century BC also helps to bridge a long-debated hiatus of

cauldron usage in Britain between approximately 600 BC, when the last Atlantic cauldrons are known, and the 2nd century BC, which before the Chiseldon discoveries were made was the earliest date that could be assigned to the IA/ER group (Stead 1998, 116; Joy 2014, 338).

All of the cauldrons recovered from Chiseldon belong to Joy’s Group II ‘globular composite cauldrons’. These ‘comprise hemispherical or slightly globular-shaped bowls, made from a single piece of copper alloy and upper bands of copper alloy and/or iron sheet. Handles and rim are made of iron and are attached to the uppermost band’ (Joy 2014, 330). Joy identified 28 Group II cauldrons, and 17 of these are from Chiseldon. The rest most commonly represent single finds. Most are distributed south of an imaginary line drawn between the Bristol Channel and the Wash.

Group II cauldrons come from a diverse range of contexts. Projecting-bellied cauldrons and the rest of the globular or straight-sided group are most often found in watery contexts, particularly bogs and lochs. In contrast, 18 Group II cauldrons are from hoards (including the 17 from Chiseldon), 5 from rivers, 3 from settlement contexts and 1 from a burial. Joy suggested that this pattern reflects the fact that in southern Britain during the 2nd and 1st centuries BC prestigious or unusual metalwork is found in a greater

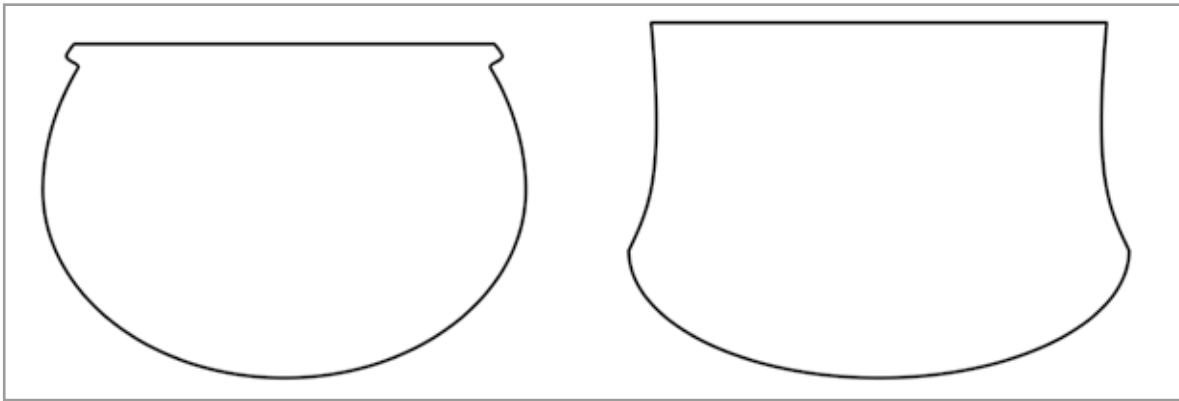


Figure 104 Profile of projecting-bellied (right) and globular or straight-sided (left) cauldrons

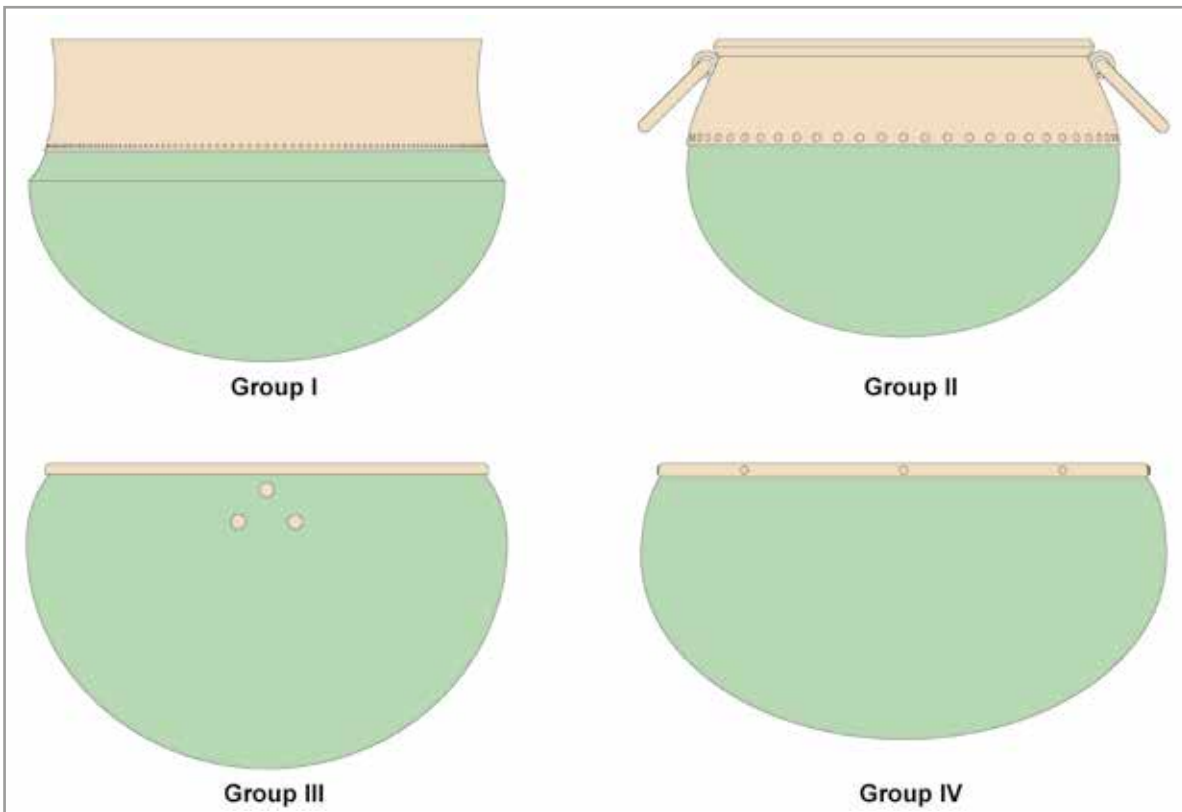


Figure 105 Typology of Iron Age (IA)/Early Roman (ER) cauldrons

diversity of contexts than earlier in the Iron Age (Joy 2014, 331). It is also linked to the fact that for much of northern Britain and Ireland, where most of the projecting-bellied and the other types of globular/straight-sided cauldrons have been found, most prestigious or unusual metalwork has been recovered from watery contexts.

Typological features

Unusually for the IA/ER group the Chiseldon cauldrons were deposited largely complete. Of particular significance is the fact that the iron rims and handles were present. For the majority of IA/ER cauldrons this was not the case and either the iron rim and handles were removed prior to deposition or they do not otherwise survive. Thus Chiseldon not only provided the opportunity to examine metalworking technology and manufacturing techniques and compare a large assemblage of contemporary objects (Chapters 6 and 8), but it also facilitated a detailed consideration of cauldron rims and handle attachments which had hitherto not been possible.

Two main types of rim were identified among the Chiseldon group: hollow and solid rims (Chapter 6). Of the other Group II cauldrons listed by Joy, only the cauldrons from Baldock, Glenfield, Letchworth and Spetisbury were deposited with rims (Joy 2014, app. b). The Glenfield cauldrons remain in their excavated state in soil blocks, making it impossible to comment on the exact arrangement of rims. Spetisbury and Baldock both have solid rims that are roughly square in section but set diagonally with one of the corners presented as the top of the rim. The rim of the Baldock cauldron is secured to the upper band by means of a slot in the bottom which the upper section of the upper band penetrates to a depth of c. 8mm (Stead and Rigby 1986, 55, fig. 23). Although the rim is not present, clips used to secure a solid rim to the upper band survive on some cauldrons, such as the example from Santon, Norfolk (Joy 2014, no. 36). What is striking from this evidence is that the hollow rim type, which comprises a good proportion of the Chiseldon group, is not common elsewhere, with solid rims seemingly

the 'standard' method of rim manufacture. With the exception of the cauldron from Letchworth, the dogleg arrangement identified with the 'hollow rim type 1' seems to be peculiar to Chiseldon. These different manufacturing techniques could relate to particular manufacturing traditions or different metalworking practices (see below).

Age and use

The range in the level of repair on the Chiseldon cauldrons compares well with Joy's cauldron catalogue but the number of repairs to fatigue cracks undertaken at the time of manufacture is markedly higher (Joy 2014, app. b). This probably points to problems in identifying this type of repair in past studies, but may also relate to specific manufacturing techniques used to make the Chiseldon cauldrons that increased the likelihood of repairs at the manufacturing stage.

Joy argued that since cauldrons were probably not used every day but were more likely used only occasionally during feasting ceremonies, many cauldrons could have been old before they were deposited (Joy 2014, 342). The evidence for widespread, multiphase patching on many of the cauldrons from Chiseldon suggests not only that they were extensively used, but also that they were valued objects and not readily discarded or disposed of through recycling, adding weight to Joy's (2014) argument.

During the cleaning of the metal, soot deposits were noted on the exterior and base of all of the complete or nearly complete cauldrons and at least five of the substantive fragments. Bearing in mind that it is not possible to determine if there are soot remains on the cauldrons that remain in their soil blocks, this is a very high proportion and indicates that all of these objects had been suspended over an open fire at least once prior to deposition, but it is difficult to determine the duration or intensity of usage.

Food residues were noted on or in 12 of the complete or nearly complete cauldrons (Chapter 9). Residues were found in the interior adhering to the bowl and rim, between the joins in the metal and around the exterior of the rim. The residues within the interior could represent burnt food remains at the position most exposed to the heat of a fire and perhaps indicate the cauldrons were not cleaned between the last time of usage and deposition. Residues found at the joins of bands and under patches or repairs are to be expected, as it would not be possible to clean these locations easily. Food residues between joins could also have served to make the cauldrons more watertight. Some of the thickest residues were found on the outside surface, particularly just below the rim and caught in the raised motifs of the decorated cauldrons; some of these were up to 10mm thick. Residues on the outside surface may suggest that the cauldrons were filled almost to the brim and the contents were spilt and/or that the contents were allowed to boil over. They could also indicate that some of the cauldrons were tipped to empty them of their contents. The swivel mechanism identified on some of the cauldron handles (Chapter 6) would allow them to be tipped while suspended, but since the decorated plates are located in the vicinity of the handles, substantial quantities of food would need to be poured out at once to create residues in these areas. Again, the presence of residues on the outside of the cauldrons

indicates that they may not have been cleaned between the period of last usage and deposition.

Cleaning would have formed an essential part of the maintenance and care of the vessels especially given that they have iron components prone to rusting. It likely involved the bulk removal of food remains rather than washing, which would promote rusting, or scrubbing which would remove the shiny, black layer, which over time would have accumulated, forming a protective surface on the interior. Cauldrons were probably only used on special occasions at which a clean appearance may or may not have been important. Decoration was also probably intended to be seen and not obscured by burnt food remains. It therefore seems unlikely that vessels were regularly left un-cleaned after usage. Yet there is evidence that some were. Cauldron 10 was found to have two different residues, one on top of the other, and many other residues can be likened to the black deposits already mentioned, like those on a frying pan or wok that have accumulated through use over a period of time and concreted onto the surface.

The lack of evidence for food residues found on other IA/ER cauldrons (Joy 2014, 341) may be due to the state of preservation of residues on metal vessels, or more likely – given the multitude of residues found on the Chiseldon examples – these other vessels were cleaned after use or before they were deposited. Alternatively, many of the cauldrons examined by Joy (2014) were found some time ago before routine analysis of residues, and past conservation of vessels and cleaning of the metal surface during restoration may have removed this type of evidence. Additionally, the residue on many of the Chiseldon cauldrons was found in direct contact with the 'original surface' and under a layer of outer iron or copper alloy corrosion, and therefore with those cauldrons that have not been cleaned, residues may be still hidden under the corrosion.

In summary, there is much evidence that the cauldrons were extensively used. They were therefore not made especially for deposition and in circulation for many years, probably decades, before they were deposited.

Decoration

It is unusual for British cauldrons to be decorated (see Joy 2014, 339–40). It is also uncommon to find several decorated objects of any kind dating to the Middle Iron Age as part of a single deposit. In this respect the Chiseldon hoard can be compared to the finds from Fiskerton, Lincolnshire (Field and Parker-Pearson 2003, especially 178–88) and Llyn Cerrig Bach, Anglesey (Fox 1946; Macdonald 2007a). Unlike these examples, the cauldrons are not from a watery context and we can therefore be certain that they originate from a single, discrete deposit.

The use of iron to make the decorated mounts

Perhaps partly because of its poor survival in archaeological conditions, particularly the surface of iron objects (see Sankot 1994), decoration in iron rather than copper alloy is rare in British Iron Age art, especially before 100 BC. Possibly the best-known examples of decorative ironworking are iron firedogs, such as those from the Baldock grave (Stead and Rigby 1986, 59–60). They represent hundreds of hours of

work, but are three-dimensional and much later than the cauldrons, dating from the later 2nd century BC, continuing in usage into the 1st century AD (see Hunter 2006; Joy 2011, 216).

Looking at decorated iron objects broadly contemporary to, or slightly later than, the Chiseldon assemblage, of the anthropoid-handled short swords from Britain, two have iron handles but detailed facial features are poorly represented, if at all, which is in sharp contrast to the example from North Grimston, North Yorkshire, which has a copper alloy handle clearly depicting eyes, nose, mouth and hair (Stead 2006, 197, fig. 105). The sword from Hammersmith (River Thames), London, has an iron scabbard decorated with a so-called dragon pair delineated by chased lines against a background of small punched dots (Stead 2006, no. 2, fig. 39). The iron scabbard from Battersea (River Thames) is similarly decorated, although the decoration is poorly preserved (Stead 2006, no. 8, fig. 42). Occasionally decoration is found on other types of object such as the iron blade of a pull-saw from Fiskerton, Lincolnshire, probably dating to the 3rd century BC (Stead in Field and Parker-Pearson 2003, 70–1, fig. 4.5) and the pair of short iron tongs from Llyn Cerrig Bach (Steele 2012, 60).

There is more evidence for decoration on iron objects on the Continent, especially where it has been revealed by careful conservation (Sankot 1994). But the types of object that are decorated are similar to those already identified from Britain: sword scabbards (both inscribed and embossed decoration as well as openwork ‘lattice-work’ mounts) and hilts, spearheads (inscribed decoration and openwork) and belt fittings. The use of raised decoration in iron is unusual in Britain and on the Continent. The closest parallels are from the Continent, in particular a series of decorated sword scabbards from the Paris basin (Ginoux 2009, figs 78–9). The decoration on these sword scabbards was created from an iron lattice-work pattern (Ginoux and Ramsel 2014, 275). Embossed iron sword scabbards are also known from elsewhere, such as the example from near Ancona, Italy (Kruta 1991, 204).

The decision to use iron rather than the more usual copper alloy to construct the decorated plates may have been based on their position on the cauldron as they directly overlie the iron upper band and sit immediately below the iron rims and handles. Perhaps the potential colour contrast of copper alloy plates with iron band, rim and handles was deemed undesirable. More likely, as the plates (and their decorations) were integral to the objects, they were made in iron to emphasise this point. The use of raised decoration is also significant because, as is shown in **Figure 81**, when in use (and provided the cauldrons were kept clean), the raised surfaces would have been picked out by the flickering firelight, animating the objects and adding to the drama of feasting events. The choice of iron is particularly pertinent for the cattle head mount on cauldron 2, as by making it in the same material as the handles, they could be interpreted as the horns of the animal when the cauldron was in use, suspended over the fire.

Stylistic dating

The following discussion will investigate the potential implications of the stylistic attributions given to the

decorated mounts (Chapter 6) for the deposition date of the Chiseldon hoard. It will also take account of the problems of stylistic dating, contributing to recent discussions interrogating the chronology of Celtic art styles (e.g. Macdonald 2007a; 2007b; Garrow and Gosden 2012).

Dating the decoration on cauldron 2

The cattle decoration on cauldron 2 is exceptional for the Middle Iron Age. Its closest parallels all belong to Stead’s Stages V and VI of British Celtic art, which he dated to the 1st century BC and 1st century AD, but even these are not that close stylistically. Stead conceded that objects decorated with Stage V art could be as early as 200 BC (Stead 1996, 34) but this still leaves a large discrepancy between Stead’s classification of art styles and the radiocarbon dates obtained for the Chiseldon hoard (Chapter 11), especially if cauldron 2 was old before it entered the ground. The existence of bovine-form art during the Middle Iron Age therefore potentially highlights some of the frailties of Stead’s (1985a; 1985b; 1996) model of a chronological progression of stages of Celtic art, as revealed by Philip Macdonald (2007a; 2007b, ch. 5) and others (e.g. Garrow and Gosden 2012). Citing examples such as the Clevedon torc from Somerset, which is decorated with multiple styles, Macdonald questioned the sequential character of Stead’s classification, particularly for Stages IV and V, which are viewed by Macdonald as being broadly contemporary (Macdonald 2007a, 332–3).

Taking account of this argument, it may be possible to push the dating of Stage V back further but since there are no other examples like the decoration on cauldron 2, it is difficult to use its presence in the Chiseldon hoard to argue that the dating of this style as a whole should be pushed back as early as the late 4th or early 3rd centuries BC, especially given that much Stage V art was produced under Roman influence (Garrow and Gosden 2012, 54). It is, therefore, not possible to assign a stylistic date to cauldron 2 and it probably should not be allocated to a single style or stage. But its presence in the Chiseldon hoard could indicate how elements of Stages V and VI art possibly have earlier origins than previously anticipated or that the inspiration for the decoration on cauldron 2 lies elsewhere, possibly from the Continent where objects such as brooches, torcs and belt clasps were adorned with human and animal likenesses.

Dating the decoration on cauldrons 5 and 6

Cauldrons 5 and 6 are both decorated in the Vegetal Style. Close parallels for the decoration on cauldron 6 can be found on torcs and armrings from the Marne region of France decorated with simple curvilinear motifs in relief. These objects date to the end of the 4th century or early 3rd century BC (Harding 2007, 77 and fig. 4.7). Elements of the decoration are also similar to the raised motif at the top of the sword scabbard from Standlake, Oxfordshire, which Stead (1996, 25) also dated to the end of the 4th century or beginning of the 3rd century BC, but could be earlier (Fitzpatrick 2007, 341).

The design on cauldron 5 incorporates a motif that can be attributed to a different style, termed the ‘Early’ Style on the Continent. Frey (1976; see also Frey in Joachim 1995,

159–206) drew a distinction between Early Style and Vegetal Style art. Rather than viewing them as stages in a developmental sequence as did Jacobsthal (1944 [1969], 162) and Verger (1987; see also Megaw and Megaw 2011, 289–94), he stated:

my purpose has been to show them as two provinces of style: two different phenomena, not two phases of the same development. Each has its own chronological place, starting within respectively the Vth and IVth century; the second overlaps the first in time, yet is differently grouped in space. Early Celtic art has grown in two successive and differing branches. (Frey 1976, 159)

Although he saw the styles as overlapping chronologically, Frey only identified one object where Early and Vegetal Styles appear together incorporated into the same design, on the shoulder of a flagon from Besançon in the Marne region of France (Frey 1976, fig. 5b). The decorative plate on cauldron 5 is a further example.

The Vegetal scroll motif was classified by Verger (1987) who identified four types or variants: A1, A2a, A2b and B (Verger 1987, fig. 1). Only two of these (A1 and B) occur in Britain (Stead 2009, 327). Type A1 tendrils are paired whereas the tendrils of Type B appear in sequence. Stead (2009, 327) identified decoration in the style of Type A1 on the Ratcliffe shield boss, the handle of the Fiskerton file and on the Standlake scabbard. Type B decoration can be found on the Standlake scabbard and in two bands on the Newnham Croft bracelet (Stead in Parfitt 1995, 90, fig. 34, nos 4 and 7; Stead 2009, 327). The decoration on cauldron 5 comprises a serpentine scroll with at least three curvilinear tendrils all in sequence, therefore belonging to Verger's Type B (Verger 1987, fig. 1). According to Verger (1987, 294) Type B is characteristic of the latter half of the 4th or the beginning of the 3rd century BC.

Few artefacts from Britain are decorated in the Early and Vegetal Styles so we have a poor understanding of their chronology. Stead (1985a, ch. 2) argued that although the few objects from Britain decorated in the Vegetal Style clearly share affinities with Continental objects decorated in the same style, the art varies in ways to suggest that it was made in Britain. This observation is supported through detailed examination of the Chiseldon cauldrons, which shows they were probably manufactured somewhere in southern England (Chapter 8). Stead (1985a, 18) argued that the Vegetal Style in Britain flowed from the Early Style. It is possible to see this process on the decoration of cauldron 5 with its combination of styles, supporting Garrow and Gosden's (2012, 80) contention that in many instances Celtic art styles should be viewed as cumulative rather than sequential, leading to styles becoming mixed.

In summary, cauldron 5 can be dated stylistically to the latter half of the 4th or the beginning of the 3rd century BC. This matches the stylistic dating of cauldron 6, which probably also dates to the same period. Similarities in the way in which the three decorated vessels were manufactured also allows us to comment on the potential date of manufacture of cauldron 2 with its bovine-style decoration. It shares a similar number of repairs to vessel 5. Each of the decorated vessels also have the same type of rim (solid rim type 1) and belong to the same type – straight convex and

flaring convex cauldrons. The decorative iron plates were all made in the same way, although there is some variation in the position of the rivets (Chapter 8). If vessels 5 and 6 were significantly older than vessel 2, there was remarkable maintenance of manufacturing traditions and techniques over time and it seems more likely that all three vessels are broadly contemporary and were made by the same group of metalworkers.

Implications of stylistic dating for the date of the hoard

Based on the radiocarbon dates obtained from the cattle skulls, Barclay and Grant (Chapter 11) proposed two likely time periods for the deposition of the Chiseldon hoard: some time between the later 4th and early 3rd century BC, or the later 3rd century BC. Stylistic dating of cauldron decoration could help to decide which of these options is most likely, although as we have already seen, account needs also to be taken of the possibility that some cauldrons were old before they were deposited.

As already discussed, based on stylistic comparison and the identification of artistic parallels, cauldrons 5 and 6 most likely belong to the later 4th century BC or early in the 3rd century BC. Because it is unique it was not possible to assign a reliable date to the cattle decoration on cauldron 2.

Applying the results of this stylistic analysis to the potential deposition dates proposed by Barclay and Grant creates two alternative scenarios:

1. *Hoard deposited in later 4th or earlier 3rd century BC.* This fits with the stylistic dating of the decoration on vessels 5 and 6.
2. *Hoard deposited in the later 3rd century BC.* In this scenario, based on stylistic dating, vessels 5 and 6 were heirlooms when they were deposited.

Evidence for use, damage and repair could help establish if vessels 5 and 6 were very old heirlooms when they were put in the ground. The assumption here is that the older the vessel, the more visible signs of age there will be. Of course, intensity of usage can skew this supposition but here it is assumed that the older the vessel, the more signs of wear, damage and repair it will display. Vessel 5 has a number of repairs including a series of four overlapping rectangular patches (see catalogue entry for cauldron 5, pp. 123–4). Vessel 6 has fewer repairs and many were probably undertaken at the time of manufacture. When compared to the other vessels from the hoard, cauldrons 5 and 6 show a similar level of wear/repair to the majority but considerably less than a small number of cauldrons such as vessel 15. In summary, evidence for wear and repair does not indicate that vessels 5 and 6 were more heavily used and therefore significantly older than the other cauldrons from the hoard. The conclusion we can draw from this is that if the cauldrons were deposited in the later 3rd century BC, many, if not all, of the vessels were upwards of 100 years old when they were deposited and some, like vessel 15, could have been far older.

Combining the evidence for manufacture, wear and repair, cauldrons 5 and 6 do not appear to have been significantly older than the other vessels in the hoard. Of course, all of the cauldrons from the hoard could have been heirlooms and the likelihood is that many were decades old when they were deposited (see above). But despite their

evident longevity, on the balance of probabilities, it seems more likely that the cauldrons were decades old and deposited in the late 4th or early 3rd centuries BC than the argument that many, if not the majority, of the vessels were upwards of 100 years old at the time of deposition.

The implications of this conclusion are considerable, as it potentially reveals a hitherto unidentified tradition of bovine art which otherwise did not flourish in Britain until the 1st century BC. Neither were earlier art styles and bovine decoration obviously separated: artefacts of the same type were decorated in these different styles, were in circulation at the same time and were used in the same social arena.

Summary

The dating of the Chiseldon hoard to the late 4th or early 3rd century BC is what one would expect for objects decorated in the Vegetal Style and demonstrates its use and circulation in Britain at the same time as on the Continent (Verger 1987). It is extremely rare to find Celtic art in independently dated contexts in Britain, particularly art dating to the Middle Iron Age (see Garrow *et al.* 2009). There is a general scarcity of British Celtic art securely dated to the 4th and 3rd centuries BC (Hamilton *et al.* 2015, 8) and with the inclusion of objects decorated in the Vegetal style, the Chiseldon hoard provides an important link to Continental Celtic art. The decorated cauldrons were made in Britain but Continental parallels for the decoration show that some contact or knowledge of Continental material culture was maintained at this time (Joy 2015b, 147). In contrast to the Continent, where brooches, torcs and belt clasps were adorned with human and animal likenesses, in Britain it is highly unusual to find zoomorphic decoration during this period. Its presence on vessel 2 further supports the theory of Continental contact.

One final question is to ask ‘why were the cauldrons decorated?’ (see Joy 2011). It is argued here that the decoration on the Chiseldon cauldrons was not merely decorative. It was also not part of a convention because it is so unusual for cauldrons to be decorated (Joy 2014). Equally the decoration cannot be separated from the object, its function and social usage, as it has been by researchers of Celtic art in the past. Objects and their decorations should be viewed as a whole. Cauldrons are substantial and visually impressive objects and decoration accentuates their appeal. The choice to employ raised decoration on three of the cauldrons is particularly important because it would have animated the objects when in use as decorative features were picked out and illuminated by flickering firelight. The cauldrons were practical objects used during feasting ceremonies. Decoration was therefore woven into wider social networks related to the production, processing, redistribution and serving of food and drink at feasts.

The question ‘why decorate?’ also could be turned on its head and we could ask instead ‘why not decorate more cauldrons?’. Perhaps the decoration did not work as intended. Without careful cleaning, through usage decoration could quickly become obscured by soot and food remains. Alternatively, the manufacturing techniques used to make decorative plates could have been the ‘signature’ of a specific group of metalworkers, which for some reason

were not more widely adopted. Maybe the visual spectacle of a large, bubbling cauldron was sufficient theatre and they did not require further elaboration.

Production context

Prior to this dating for the Chiseldon hoard, it was thought that IA/ER cauldrons were made during the 2nd and 1st centuries BC, allowing their manufacture, particularly in southern Britain, to be linked to a period of increasing social hierarchisation (see Creighton 2000; 2006) and the aggrandising activities of an elite (Fitzpatrick 2009). But if, following the arguments set out in more detail below, societies in Middle Iron Age Wiltshire were relatively flat and generally lacking a distinct social hierarchy, what would be the motivations for investing time and resources into making complicated metal artefacts such as cauldrons? Were they made by specialists and, if not, how was their manufacture organised?

Artefact production in Wessex

Sharples (2010, 124–46) recently comprehensively reviewed the evidence for artefact production in Wessex and the following account is presented as a brief summary of his conclusions, particularly regarding the Middle Iron Age and evidence for specialist production.

Pottery coarse ware jars and fine ware bowls are characteristic of the Early Iron Age and there is possible evidence for specialised production, but for the most part the manufacture of ceramics was localised and intended for local consumption (Morris 1994). Around the 4th century BC the quality and diversity of pottery declined and decoration became less frequent. This transitional phase was relatively short and new ceramic forms and regional styles are seen by the 3rd century BC. Some of these new forms were produced at specialist production centres (Morris 1994). Artefacts made of stone include shale bracelets, whetstones and querns. Armlets were also made from Kimmeridge shale obtained from the Isle of Purbeck in Dorset (Sharples 2010, 130–1). Stone to make querns was located from specific sources and artefacts were widely distributed (Peacock 1987).

Signs of ferrous and non-ferrous metalworking, including slag and crucibles, have been found both at hillforts and at smaller enclosed settlements but evidence is slight. Before 300 BC iron was produced locally using ores sourced from nearby. This changed after 300 BC when smelted iron was imported as a raw material from sources outside Wessex. Manufacture of copper alloy objects took place on a limited scale across all types of site but was largely restricted to the production of brooches, other small items of personal adornment and horse harness equipment. Finds of other items, particularly weaponry found in rivers (Fitzpatrick 1984; Bradley 1990), indicate the presence of highly skilled metalworkers and the limited manufacture of a wider range of metal objects at this time. Many sites show evidence for the production and working of iron and copper alloy objects in the same location, indicating there were no clear distinctions between the production of ferrous and non-ferrous artefacts. Arguments have been put forward suggesting there was a split between the manufacture of cast copper alloy objects at unenclosed settlements and sheet

metalworking at hillforts (Northover in Sharples 1991, 161), but because of the limited and diverse nature of the evidence this interpretation is treated with caution, particularly as the evidence presented for this split occurred later than the period in which we are interested. Nevertheless, the presence of fragments of sheet metal vessels at hillforts such as Cadbury Castle, Danebury and Maiden Castle could be viewed as evidence for the use, repair and recycling of sheet metal objects such as cauldrons at hillforts (Sharples 2010, 145–6). There is also evidence in the later Iron Age for locations of short-lived, intense metalwork production (e.g. Gussage All Saints) but this does not appear to be the case in the early part of the Middle Iron Age.

To summarise this brief review of artefact production in Wessex (although there is limited evidence for specialist manufacture of some ceramic and stone artefacts), metalworking at the time the Chiseldon cauldrons were manufactured can be best characterised as small-scale and uncentralised. A limited quantity of iron tools and copper alloy items of adornment were made alongside a small number of prestige items such as weaponry. While the quality of many items shows metalworkers were clearly highly skilled, there is little evidence for specialised manufacture in dedicated areas or workshops (Ehrenreich 1991, 77).

The organisation of metalworkers

Essential to our understanding of the context in which the Chiseldon cauldrons were made are the activities of the craftspeople who made them. Despite a general paucity of evidence to support the argument, prestige metalwork, particularly so-called Celtic art, has long been thought to be the product of specialist craftspeople working in dedicated workshops and sponsored by an elite (e.g. Fox 1958; Jope 1995; 2000). One of the many problems with this argument is that some of the finest examples of metalworking, such as display shields, were made during the Middle Iron Age at a time when, as we have already seen, we have little obvious evidence for an elite. It is also unsafe to assume that just because something is well made, it was made by specialists. Some time ago when examining ironworking during the Middle and Late Iron Ages in southern Britain, Robert Ehrenreich (1991) demonstrated the danger of simplistic linkages between craft specialisation and socioeconomic complexity by drawing a distinction between iron smelting, which he thought was undertaken by specialists, and iron smithing, which he viewed as a non-specialist activity. The main thrust of his argument was that quality of manufacture alone does not provide sufficient evidence for craft specialisation and other forms of evidence such as high-volume production, dedicated workshop areas and control of resources are also required. The general paucity of this type of evidence from central and southern England led Ehrenreich to conclude that iron smithing was performed by craft persons and not by craft specialists (Ehrenreich 1991, 77).

Drawing on these observations and given the evidence we have, is it possible to fashion further conclusions concerning the organisation and skills of the craftspeople who made the Chiseldon cauldrons? Cathy Costin highlighted two types of

evidence which can aid in reconstructing the organisation of production: direct and indirect (Costin 1991, 18). Direct evidence involves identifying production sites and production debris; the categories of evidence also valued by Ehrenreich but largely lacking for Middle Iron Age Wessex. Indirect data are obtained from the objects themselves. Since there is little or no direct evidence for the manufacture of cauldrons in the region during the 4th and 3rd centuries BC, we are reliant on the indirect data derived from the cauldrons, looking for consistencies in terms of shared technologies, raw materials and details of manufacture (Costin 1991, 33).

On first inspection, it would appear that the Chiseldon cauldrons represent clear evidence for craft specialisation. They are skilfully made and, based in particular on comparison of the iron rims, at least two different methods of manufacture can be identified (Chapter 6), with the dogleg construction standing out as sufficiently different from the remainder of the cauldrons to suggest they may represent the work of a separate individual or group. But as Ehrenreich (1991, 78) argued, reasoning that metalworkers were specialists requires a level of evidence beyond just noting the high level of skill of metalworkers, such as evidence for dedicated workshops or control of the flow of raw materials. Although as we have seen there is limited evidence in Wessex for specialist manufacture of some ceramic and stone artefacts, evidence for modest ferrous and non-ferrous metalworking such as slag and crucibles has been found at a range of different types of site across Wessex, indicating that metalworking activities were small-scale and uncentralised. The metal stock used to manufacture the cauldrons was also heterogeneous in nature (Chapter 8), implying only loose control at best over resources as materials were probably obtained when and where they were available. Further to this, no single cauldron is the same; each is a bespoke item, suggesting their manufacture was non-standardised and they were, therefore, not produced in large numbers. High amounts of variability can be interpreted as resulting from small-scale production and different cultures have different levels of acceptance of variability (Costin 1991, 36). Based on the wide variability in the form and quality of artefacts, it could be argued that there was a high cultural acceptance of variability in Wessex during the Middle Iron Age. The number of repairs and patches applied to the cauldrons at the time of manufacture also supports the impression that they were not mass-produced, as had they been made in large numbers, one might expect many of the deficiencies observed in the manufacturing process to have been ironed out. Standardisation also has wider implications beyond craft specialisation. Standardisation of artefacts implies that relations between people and cosmological entities are also standardised (see Gosden 2013, 45). On the whole, this is not a pattern we see in the Iron Age of Wessex, with ritual practices varying from place to place and over time (Hill 1995b).

The distinction between specialist and non-specialist production is difficult to define and is in many ways academic as, given the quality of the evidence we have currently for Iron Age metalworking, it is very difficult to

make firm conclusions on either side of the debate. Even if, following Ehrenreich's strict classification, the metalworkers who made the cauldrons were not specialist cauldron makers, sophisticated techniques were clearly employed in the manufacture of the cauldrons. How then do we explain their relative sophistication? As Ehrenreich (1991, 79) made clear, absence of craft specialisation does not imply that techniques remain simple and static. In a separate paper he identified evidence for quenching at settlements and hillforts and demonstrated that ironworking at this time was quite dynamic (Ehrenreich 1985, 82). The use of sophisticated techniques such as quenching, the extreme reduction in the thickness of metal to manufacture cauldron bowls, and the heterogeneity of the Chiseldon cauldrons all follow patterns exemplified by Ehrenreich (1991). He suggested that this type of evidence resulted from attempts by different groups to improve the design and manufacture of artefacts through experimentation, but that once techniques were developed they remained 'proprietary' and were not shared with other individuals or groups (Ehrenreich 1991, 79). This could explain, for example, why the technique of raised decoration on iron mounts was not copied or used elsewhere. The presence of marking out lines indicates that aspects of cauldron design and manufacture were often well thought out, providing the impression that designs were the product of considerable experimentation and planning. The different methods of manufacturing may indicate the production of the cauldrons by different groups or individuals but it could also be evidence for changes in techniques over time. Following Ehrenreich, therefore, the pattern of metalworking suggested by the Chiseldon cauldrons 'should not be seen as simplistic, but as dynamic and complex with many different ... [metalworkers] all attempting new techniques and not confined to a set hierarchy' (Ehrenreich 1991, 79).

Manufacture and repair

In an analysis of Ohio Hopewell artefacts, Spielmann (2013, 148) identified three classes of crafting: highly skilled, technically adept and unskilled. In the example of the Chiseldon cauldrons, a difference in skills is most evident not between the quality of manufacture of individual cauldrons, but between those metalworkers capable of making complicated metal objects such as cauldrons from scratch and those individuals able to execute often crude but effective repairs. Following similar observations deduced from the study of Bronze Age Atlantic cauldrons (Northover and Gerloff 1988), repairs made to the Chiseldon cauldrons were often technically adept but quite rudimentary, using whatever materials were available at the time. Viewed from this perspective and applying Spielmann's categories, it could be argued that in Middle Iron Age Wessex there existed some highly skilled metalworkers able to turn their hands to making complicated artefacts such as cauldrons or items such as swords. Some sophisticated repairs also appear to have been undertaken by these individuals, such as the possible replacement of the rim of cauldron 3 (Chapter 6). At the same time there were technically adept individuals, probably available to every community, capable of executing repairs to objects.

Given the scarcity of metal artefacts, it is unlikely that demand was ever high enough for skilled metalworkers to support themselves solely through metalworking; they were possibly part-time, combining craft production with agriculture (Costin 1991, 17). They were probably not specialists at making any particular artefact, certainly not cauldrons. The variability of the cauldrons is too great and there are too many mistakes which had to be repaired and patched at the time of manufacture (see Costin 1991, 40). The fact that repairs were executed by individuals who were technically adept, but not necessarily the highly skilled metalworkers who made the cauldrons, shows these highly skilled individuals were not always available, perhaps because they moved from place to place, or that they worked seasonally, linked to the agricultural cycle.

Therefore, in summary the Chiseldon cauldrons probably represent the products of highly skilled metalworkers, but these metalworkers were not specialist cauldron makers. If output and demand were relatively low, it is also unlikely that many highly skilled metalworkers were needed, nor that their production required large-scale facilities. A difference in skills between those able to make objects from scratch and individuals capable of executing simple repairs has, however, been identified.

The depositional context of the hoard with A.P. Fitzpatrick

Although the evidence is slight it seems likely that the hoard was deposited in, or near to, a contemporary settlement. The geophysical survey identified a dense cluster of pits to the north of the hoard (probably the remains of an unenclosed or open settlement) but mostly Roman pottery was found in the fieldwalking survey. The hoard pit (pit 133) was dug through one or more, earlier, though otherwise undated, pits. The materials incorporated within the backfill of pit 133 also suggest that there was a settlement nearby. The 4th-century BC pottery is in a range of fabrics, implying that it came from the typical variety of pots used in a settlement, and the mixed species among the charcoals are characteristic of the rakings from fires. The remains of spelt and barley are normal for Middle Iron Age settlements not far to the north in the Thames Valley and they also include evidence for crop processing. A standard range of domestic animals is represented among the animal bones, many showed signs of having the marrow extracted from them, while a significant number of the small splinters had been in direct contact with fire. Although it cannot be demonstrated that this settlement material is strictly contemporary with the deposition of the hoard, several strands of evidence suggest that it may well have been. The dates of the pottery, the composition of the bronze alloy used for the cauldrons (Appendix A), the stylistic dating of the decorated cauldrons (see above) and the radiocarbon dating of the cattle skulls, which were all arrived at independently, all fall in the 4th–2nd centuries BC. The charred plant remains in the backfill include chaff from cereal processing, which typically only survives when it is buried or reburied rapidly. The animal bones show no traces of gnawing by dogs, suggesting they were buried or reburied swiftly.

Settlement and population

Chalk downland is one of the defining features of the Wessex landscape (Sharples 2010, 15). The downland is relatively dry and is crossed by steep-sided valleys known as coombs, but it is probably best known for its steep escarpments and the rich grassland which was extensively exploited throughout the past for grazing sheep. In addition to downland, areas of clay with flints, which are comparatively difficult to cultivate, provided important woodland resources and valley bottoms offered seasonal grazing for cattle (Sharples 2010, 15–23).

The downland was relatively densely populated throughout the first millennium BC. Prehistoric field systems date back to the Middle Bronze Age (Fowler 2000, 86–7). These comprise ‘blocks’ of divided fields that Gingell suggested were linked to single farmsteads distributed at intervals as close as 0.5km (Gingell 1992, 155). They did not last long and were abandoned by the Late Bronze Age (Sharples 2010, 43), but cereal grains and chaff uncovered at Uffington Castle, Segesbury and Alfred’s Castle show that, even if the fields cannot be identified, arable farming was taking place throughout the Iron Age (Lock and Gosden in Lock *et al.* 2005, 137). Excavations approximately 10km to the north of where the Chiseldon hoard was found also revealed field systems of Early, Middle and Late Iron Age date (Chapter 2). Modelling from these settlement patterns, it is argued that a range of enclosed and unenclosed settlements probably existed in the region. This assessment is supported by Sharples’ (2010, fig. 2.17) wider survey of the Wessex region, which showed a mix of diverse enclosed and unenclosed settlements formed of small farmsteads farming adjacent land.

Enclosures

During the Late Bronze Age and Early Iron Age, enclosures (large and small) became a central feature of the Wessex landscape, particularly enclosure ditches related to individual farmsteads and the substantial banks and ditches of hillforts (Sharples 2010, 116–20). The position of the hoard is overlooked by three hillforts: Barbury Castle, Plough Hill (Chiseldon) and Liddington Castle. Both Barbury Castle and Liddington Castle are situated at the intersection between the River Og and the chalk escarpment that forms part of the Ridgeway, along which are a large number of hillforts known as the Ridgeway Group. Liddington Castle was built some time in the 7th or 6th century and was modified during the 4th or 5th century but it was abandoned soon after (Hirst and Rahtz 1996, 42; Bowden 2005, 158; Payne *et al.* 2006, 111–18). The fort at Plough Hill has yet to be fully investigated but it perhaps dates to the Late Bronze Age or Early Iron Age (Chapter 2). From c. 500 BC to 200 BC some hillforts were significantly modified. Known as ‘developed hillforts’, these show alterations including the development of entrances and the addition of multiple ditches and ramparts (Cunliffe 2005, 590). In general, developed hillforts were also densely occupied. Barbury Castle has been viewed as a classic example of a developed hillfort. At some point during the Middle Iron Age its ditches and ramparts were extended and remodelled and geophysical survey of its interior revealed pits and circular

structures interpreted as houses, indicating that at the time the Chiseldon hoard was deposited, the fort could have been densely occupied (see Payne *et al.* 2006, 103). It was probably abandoned some time in the 1st century BC (Payne *et al.* 2006, 103).

In summary, at the time the Chiseldon hoard was deposited, Liddington Castle and the possible hillfort at Plough Hill were unoccupied but it is credible that a reasonably large group of people occupied Barbury Castle. The rest of the population probably lived in small farmsteads, practising mixed agriculture. The deposition of the hoard corresponds to the time when the ramparts of Barbury Castle and a series of other so-called developed hillforts were remodelled. It is possible that these activities and the Chiseldon hoard were in some way related.

Possible significance of the location of the hoard

The Ridgeway

The Chiseldon hoard was deposited probably in a settlement close to the Ridgeway. This is a trackway which extends along the chalk downlands and which may have ancient origins (Lock and Gosden in Lock *et al.* 2005, 135) and may have made the Chiseldon hoard somewhere that was easily accessible to different communities or groups. It was possibly established initially, perhaps before the Neolithic, by animals (Bell and Lock 2000), but people then adopted it because movement from east to west across this part of the downs was otherwise restricted by dry valleys. Fowler (2000, 22) questioned the Ridgeway’s ancient pedigree, arguing it is post-Roman with its origins somewhere between the 5th or 6th centuries AD and the early decades of the 10th century. Sharples (2010, 68) also queried how easy routeways following escarpments were to traverse. Even if, as many others contend, the Ridgeway has more ancient origins, computer simulation has shown that the modern route may deviate from a possible ancient trackway, with the hillforts at Liddington, Hardwell Camp, Uffington, Rams Hill and Segesbury all originally constructed directly on the trackway, which ran through them (Bell and Lock 2000, 135–6). GIS modelling of ‘least cost pathways’ across the landscape has revealed how in the vicinity of Barbury Castle and Liddington Castle, the Ridgeway was potentially poorly defined (Lock and Pouncett 2010). Instead, according to Lock and Pouncett, hillforts such as Liddington Castle may have acted as points of reference within the landscape defining ‘... a “corridor of intentionality” through which movement took place’ (Lock and Pouncett 2010, 200). This is important because it means that even if the Ridgeway is later in date than the Iron Age as Fowler contended, the hillforts in the area probably still acted as significant references when traversing the Iron Age landscape.

Pit circle

Proximity to a possible Late Neolithic/Early Bronze Age pit circle as well as other features in the landscape may also have had an important bearing on the choice of location for the Chiseldon hoard. Identified by the geophysical survey and located 60m to the southwest of the hoard, the pit circle is c. 25m in diameter (see Urmston, Chapter 2). It probably

dates to the Late Neolithic and Early Bronze Age (see Barclay and Marshall in Fitzpatrick 2011, 183), but could have been in use for many centuries. Some or indeed all of the pits in this monument may have originally held timber posts or even standing stones, although none of these remain and it is impossible now to ascertain how visible this monument was in the Iron Age. Memories can be shaped, formulated and perpetuated by the landscape (Schama 1995). It is possible that even if the pit circle was no longer a conspicuous feature, collective social memory (Van Dyke and Alcock 2003) of the monument could have persevered, leading it to have been viewed as a significant location in the landscape. This may have helped to enhance the status of the nearby settlement where the hoard was deposited, as a place suitable for communal gatherings and/or ceremonial artefact deposition.

A 'journey of knowledge'?

Setting aside discussions as to the age of the Ridgeway, it is probable that the hillforts in the area around Chiseldon acted as important waymarkers in the landscape, making the settlement the hoard was deposited in relatively easy to locate. It is also possible that in accessing the location of the Chiseldon hoard, travellers had to cross boundaries and pass specific places in the landscape, such as the possible pit circle, which were significant and about which stories were told (Chadwick 2016, 112). Even if their original purpose had been long forgotten, new stories could have been created, weaving them into existing belief systems and mythologies (Tullett 2010a, 118). Travelling to the site of the Chiseldon hoard could therefore have been a 'journey of knowledge' as well as a journey through the landscape (Tullett 2010a, 118).

At present there is a lack of evidence for formalised demarcation of space at the location of the Chiseldon hoard. Further investigation of the settlement may tell us more, but if there was no formal demarcation, it does not mean the setting of the hoard was not significant. Looking at other societies, many communal ritual spaces are unelaborated and ceremonies such as feasts can take place within settlements, or in spaces especially cleared for the occasion (Spielmann 2008, 46). Travel along a prescribed route, passing significant locations in the landscape, could have been an important component in the choice of location, acting to reinforce the position of the community within the landscape.

The arrangement and contents of the hoard

In this section we set out to reconstruct the sequence of events leading to the formation of the Chiseldon hoard and to reveal some of the relationships made manifest through its creation. Hoarding in Wessex peaked during the Late Bronze Age into the Earliest Iron Age (Haselgrove 2015). The frequency of hoards then dropped off markedly. Hoarding did not resume on a significant scale until a phase of iron hoarding which occurred at enclosed settlements and hillforts during the 3rd century BC (Haselgrove and Hingley 2006). Similarly, no hoards containing Celtic art can be definitely dated before the 2nd century BC (Garrow and Gosden 2012, 159). Garrow and Gosden (2012, ch. 6) identified 75 deposits containing Celtic art from 65 different

sites, deposited in two main phases from the 2nd century BC into the 1st century AD, separated by a brief hiatus in activity between 20 BC and AD 40. The deposition of decorated cauldrons at Chiseldon precedes the majority of these deposits by some two centuries.

With the notable exception of Haselgrove's (2015) recent survey, the study of hoarding has occupied a largely peripheral position in Iron Age studies when compared to work on the British Bronze Age (e.g. Bradley 1998; 2005; Needham 2007). There has been much debate concerning the nature of individual sites (see for example discussions of Snettisham, Norfolk, especially Stead 1991 and Fitzpatrick 1992), and regional studies such as Hutcheson's (2003; 2007) work in Norfolk and Hunter's (1997) survey of Scotland and Northern England. Hingley (1990; 1997; 2005; 2006) also comprehensively reassessed iron deposits (see also Haselgrove and Hingley 2006). Interpretations of the motivations behind hoarding as a practice have changed over the years, moving from an emphasis on deposition for safekeeping and later retrieval (e.g. Clarke 1954) towards a view of hoards as votive deposits (e.g. Fitzpatrick 1992). Another key avenue of enquiry has been to consider how different hoards really are from other types of deposition, such as single or watery deposits (Fontijn 2002; Yates and Bradley 2010) and depositions in the same location which accumulated over time (Haselgrove 2015, 27). At the core of these discussions are concerns as to how marked were the distinctions between the sacred and the everyday in prehistoric societies (Brück 1999; Bradley 2005) and the fact that many different types of deposit appear to have been deliberate (Hill 1995b). In Wessex, as elsewhere in Britain, there was a tradition of placing selected objects in settlement features such as pits and ditches. These start around 600 BC and are often termed 'special deposits' (Cunliffe 1995; Hill 1995b; Sharples 2010). Special deposits include bits of humans and animals and worked antler and bone, but before 300 BC metalwork was rarely included (Haselgrove 2015, 29). From 300 BC, sites such as Danebury show a marked increase in metalwork deposition in hoards and special deposits (Haselgrove 2015, 29). There is therefore significant '... blurring of the boundaries between different types of deposit' (Garrow and Gosden 2012, 157) and in the context of this discussion, following Haselgrove (2015), no rigid distinction will be drawn between hoards and other forms of deliberate deposition.

The Salisbury hoard, deposited in a pit at a settlement site sometime around 200 BC, is one of the closest known hoards both chronologically and geographically to Chiseldon. It is an eclectic mix of Bronze Age tools and weapons, some dated as early as 2400 BC, and Iron Age miniatures including shields and cauldrons (Stead 1998). It is notable because it includes objects from such a large chronological range. Presumably, it is made up of a number of Bronze Age hoards discovered during Iron Age agricultural activity to which was added a range of miniature artefacts before it was deposited (Stead 1998, 123). A second hoard also containing an assortment of Bronze Age and Iron Age artefacts is known as the 'Batheaston' hoard but was probably found in the vicinity of Wylve, Wiltshire, only 16km from the Salisbury hoard (Stead 1998, 121–2). The Iron Age

component of the hoard is different from Salisbury, containing a large number of pins and brooches dating to the Middle Iron Age (Adams 2013). Without wanting to imply that the two hoards were deposited for the same reason, we might suggest that they both hint at the possible values placed on already quite ancient artefacts at this time, perhaps drawing on concepts of genealogy or a mythical past (Hingley 2009).

A hoard of iron objects including tools, weapons and horse fittings was found at Barbury Castle. MacGregor and Simpson (1963) suggested a date for the hoard of 200–50 BC, but Manning argued that ‘a later date is equally or more likely, for almost all the pieces in it can be paralleled in an immediately pre-Roman context’ (Manning 1972, 231). Hingley (1990; 2005) has also drawn attention to a series of hoards and other types of deposit containing iron so-called currency bars. Currency bars were made in a variety of forms, primarily ‘sword’ and ‘plough-share’ shapes. The majority were deposited between the 3rd and 1st century BC and are quite widespread but with a concentration in Wessex, particularly at the boundaries of settlements, including hillforts. Hingley (1997) interpreted currency bar hoards as votive deposits, linked to their position at site boundaries and the symbolic value placed on items used to produce tools and weapons.

Looking at a small selection of other types of deposition, some larger special deposits which include metalwork are known from the region. The accumulation of horse gear and other artefacts found at Bury Hill, Hampshire was primarily recovered from two pairs of adjacent pits (Cunliffe and Poole 2000b; Garrow and Gosden 2012, 280–7). Deposition coincided with a phase of remodelling of the fortifications towards the end of the Middle Iron Age and there were a number of different depositional episodes (Cunliffe and Poole 2000b, 80). The presence at the site of horse trappings and an unusually large assemblage of horse bones prompted Cunliffe and Poole (2000b, 81) to argue that something quite different was occurring at this time at Bury Hill as opposed to Danebury. Garrow and Gosden (2012, 280–7) reinterpreted the Bury Hill finds and suggested that two of the pits (P24 and P45) contained the burnt remains of a chariot. Drawing on Hill’s (1995b, 116) observation that deposition could have been used to signal the difference between sites, Garrow and Gosden suggested that Bury Hill was clearly distinguished from Danebury through these depositional activities.

This brief survey shows that although hoards were rare in the period during which the Chiseldon hoard was deposited, other types of deposition did occur which may have served similar purposes. Like Chiseldon, the majority of these deposits occurred at settlements. As has already been suggested, many of these deposits may have been associated with periodic events and rituals such as feasts (Hill 1995b). Depositional acts were probably also negotiations with the supernatural, specifically concerned with the regeneration of society. As discussed in relation to the chariot remains at Bury Hill, deposition could have served to mark differences between sites and communities (Hill 1995b, 116; Garrow and Gosden 2012, 280–7). There was a broad cultural tradition of ritual deposition throughout Wessex but specific practices

varied from place to place and over time, with deposition acting as an important arena for statements and renegotiations of identity. As we saw from the examples of the Salisbury and Batheaston hoards, we should be wary also of implying universal motivations. Deposits vary widely and probably served distinct purposes.

Organisation of society at the time the hoard was deposited

Much Iron Age scholarship has focused on Wessex and since Hawkes’ (1931) ABC model, this has been especially the case concerning discussions of social organisation and change. This is due to a number of factors including the prevalence of hillforts in the region which have attracted much attention, the relatively well-preserved archaeology and also the coincidence that many important antiquarians, as well as key figures in the history of Iron Age archaeology, selected the region as a focus of study and excavation (Evans 1989; Champion 2001, 9).

Two competing social models have dominated recent discussions of Iron Age society: the hillfort and household models. Based in large part on information derived from his Danebury excavations, Cunliffe (1974; 1984a; 1984b; 1995; 2005) proposed a society in which hillforts operated as elite residences, a venue for feasting activities and distribution centres, acting as central places controlling production and exchange. Over time, power coalesced into fewer ‘developed’ hillforts with larger territories connected to tribal boundaries. Cunliffe’s model was supported by evidence derived from classical and medieval Irish texts and underpinned by a belief in a pan-European Celtic society. It was criticised almost as soon as it was proposed (Sharples 2010, 2). Some objected to what they viewed as its oversimplification of Iron Age society (e.g. Hill 1989; 1996). Similarly, others stressed the heterogeneous nature of hillforts, settlement patterns and the use of boundaries (e.g. Hingley 1984; Sharples 1991). A further group critically appraised the archaeological evidence for hillforts as elite centres and central places (e.g. Stopford 1987; Marchant 1989). The existence of elites in the Early and Middle Iron Ages was contested and it was argued instead that social hierarchies were relatively flat (Hill 2006; Sharples 2007; 2010; Hill 2011). Sharples (2007; 2010) also recently contended that as a consequence of a focus on production and distribution, following the hillfort model the economy is artificially isolated from other social and religious activity.

An alternative view of society focused on individual households coalesced largely in reaction to Cunliffe’s proposal (e.g. Hingley 1990; Hill 1993; Hill 1995a; 1996; Parker-Pearson 1996; Oswald 1997). According to the household model, society was not especially hierarchical and there was a considerable degree of independence among individual households and each formed a ‘complete productive unit’ (Hill 1995b, 104), controlling access to resources and allocation of surplus. Land was divided and controlled by households, with resources such as common downland and water meadow shared by the wider community. A criticism that can be levelled at the household model is that it creates many small ‘atomised’ social units; although acknowledged, this criticism is largely ignored

(Tullett 2010a, 62). In order for households to reproduce themselves they must participate in wider community structures, including periodic assemblies of people to facilitate trade and exchange, hold religious ceremonies and arrange marriages. Feasting is an obvious forum for these activities (Hill 1995b, 105; 2011, 245). Although this is acknowledged by proponents of the household model, little hard evidence has been provided for these activities (although see Fitzpatrick 1997, 75). A further criticism is that the household model does not explain cultural change, as society is seen to alter little from the Early to Late Iron Ages (Sharples 2010, 4).

More recently discussions have asked new questions, proposing alternative perspectives by questioning ‘what is an elite?’ (Hill 2006; 2011), suggesting new mechanisms of social reproduction such as fosterage (Karl 2005), examining the importance of land tenure (e.g. Giles 2012) and questioning the existence of neat, bounded tribal social units (Moore 2007a, 2007b; Leins 2008). A number of authors also continue to argue that for most of the Iron Age, societies were not especially hierarchical (e.g. Hill 2006; Cripps 2007; Moore 2007a, 2007b; Sharples 2007; Hill 2011; Giles 2012). Hill (2011) proposed what he termed a ‘non-triangular’ structure to society. By this he meant that rather than a small number of individuals or households at the apex of a social pyramid as implied by the hillfort model, society was more like a rectangle or trapezoid with potentially large numbers of adult men all sharing a similar status. Formal institutions such as a council of elders, or an assembly, may have officiated over allocation and access to resources with multiple leadership roles held by individuals whose status was achieved, not inherited.

In his comprehensive study of the later prehistory of Wessex, Sharples (2010, 112–24) constructed a long-term narrative of social change. In contrast to other parts of Britain such as the Thames Valley, in Wessex he argued there was an increase in the quantity of bronze in the archaeological record dating to the Earliest Iron Age (c. 800–600 BC). Bronze axes were imported from Brittany and deposited in hoards and he saw these as evidence for gift exchange networks between Wessex and the Continent. Unlike the Middle Bronze Age, the quantity of material was not huge (see Roberts *et al.* 2015, 365–6) and it is likely that these exchange networks were limited to certain groups within society, with others seeking to build more local connections through the exchange of pottery. As there are few, if any, known metalwork hoards from the period 500–300 BC, social competition, he argued, was no longer focused on the consumption of material wealth as it was in the Bronze Age. The general plainness of almost all of the material culture from this period and the paucity of evidence for marked social stratification indicate that social networks in southern Britain became more localised and status was negotiated in new ways, principally the organisation of labour to construct boundaries, including remodelling the ramparts of so-called ‘developed’ hillforts. As we have seen, the landscape of Wessex was dominated by hillforts but, rather than these being the result of elite activities as Cunliffe argued, Sharples placed an emphasis on their construction. This was communal and the construction,

particularly the remodelling of hillfort ramparts and entrances, is viewed as a form of conspicuous consumption centred on human labour, rather than on high-value exotic materials as in the Bronze Age.

Bringing all of this evidence together, what can we conclude concerning social organisation in this part of Wessex at the time the Chiseldon cauldrons were deposited? There is little evidence for the existence of distinct social hierarchies, or that hillforts in the region acted as centres for production and exchange. As already stated, for the most part people lived in individual farmsteads. The single so-called ‘developed’ hillfort, Barbury Castle, provides evidence for more aggregated settlement and could have been home to a chiefly elite, but its inhabitants may equally have been formed of a co-resident community with a relatively flat social hierarchy. Other possible indicators of distinct social hierarchies such as richly furnished burials, or large houses or buildings, are also absent from the record so it seems social structure at this time was probably relatively flat. Settlement patterns were quite diverse but most of the population was dispersed, coming together at various times to participate in matters of wider concern.

The household model therefore better fits the contemporary settlement and landscape evidence present in the environs of the Chiseldon hoard. Nevertheless, as has already been outlined, this model is also imperfect as the mechanisms for the continuation of a society of households, such as feasting, are frequently cited by proponents of this model, but frustratingly they are rarely explored in detail. As Andy Tullett (2010b, 69–72; see also Moore 2007a, 80) argued, the household model of society is also problematic when attempting to identify a community as it involves searching for something outside of the core social unit of the household.

The sequence of events and arrangement of the hoard

The meaning of individual hoards is probably now lost to us but we can examine what hoards do: how they take objects out of circulation and physically manifest relationships between artefacts through the inclusion, exclusion and juxtaposition of specific artefact types and individual artefacts (Joy 2016). The pit was dug with a diameter of 2m and to a depth of around 1m. Once it was excavated, it was possibly lined with wood, although this would be very unusual in an Iron Age context. More probably it had a straw lining and the cauldrons, cattle skulls and possibly also wooden implements were placed inside it (Chapter 10). One cattle skull was set the right way up, the other upside down and the cauldrons at the edge of the pit were placed on their sides. Further straw may have been used as a packing material. The lining of the pit and the positioning of the outermost cauldrons suggests careful placement, but the cauldrons towards the centre were arranged more haphazardly with some piled and stacked on top of one another. Whether this is because of a lack of space or for some other reason is difficult to establish. Cauldron fragments were also deposited in the middle of the pit in the top layer of the deposit. Unfortunately, it is impossible now to reconstruct and quantify the exact layout and number of these fragments because it was the area most disturbed by

the activities of the metal detector user when he first discovered the hoard.

The pit was filled soon after it was dug, as is evidenced by the good condition of the cattle skulls (Higbee, Chapter 7) and the homogeneous nature of the soil fill. After a period of time, when the fill of the pit had slumped, the ground surface was levelled. Whether this was a deliberate attempt to mask the location of the deposit or to make the ground surface more usable is difficult now to establish. The area seems to have been an active one as is shown by the earlier pits seen during excavation and the pits, some of which may have been Iron Age in date, recorded during geophysical survey.

When were the cauldrons damaged?

The evidence of damage to some of the cauldrons prior to their deposition outlined in Chapter 6 correlates with the findings of Joy (2014) who noted that many IA/ER cauldrons may have been partially dismantled prior to deposition. Especially prevalent, according to Joy, was the removal of the iron rim and handles; certainly these elements rarely survive. Interestingly, despite the fact that the proportion of objects that were damaged in the Chiseldon hoard is similar to the proportion observed by Joy, a number of different damage patterns emerge at Chiseldon. All seven of the damaged cauldrons are missing at least one handle but only one of the seven is missing both handles. Five cauldrons are either lacking a base or the copper alloy has been extensively damaged, rendering the cauldron unusable. Where the site of dislocation is visible it appears the bowls were torn rather than cut away, or detached along the B/C riveted join. This possibly indicates that dislocation of elements occurred at or near the location of burial rather than being undertaken by a skilled craftsman preparing artefacts for repair or recycling. Howsoever it was achieved, there is probable evidence for the decommissioning of complete cauldrons prior to their deposition and/or the retention and then mass burial of previously damaged vessels. The handles and the bowl are the areas that would take most strain during use, and would therefore be the most likely to be damaged. Additionally, they are the areas of the vessel that would require skilled craftspeople to repair them, unlike smaller areas of damage which were easier to repair with patches (Chapter 6).

In summary, IA/ER cauldrons are rarely found complete and presumably many were partially or wholly dismantled, or 'unmade', prior to deposition or the rims and handles did not survive for some other reason such as poor preservation (Joy 2014, 342–3). In this sense, the Chiseldon assemblage appears unusual as it contains so many complete cauldrons. But exactly how 'complete' the cauldrons were can be questioned as many were damaged to the extent that they were unusable and could not be repaired without the aptitude of a skilled craftsman; for example, seven cauldrons were missing at least one handle and five were deposited without a base. The fact that so many cauldrons were damaged and, where visible, bowls were torn rather than cut away, may indicate that dislocation of components took place at or close to the time of deposition rather than representing damage during use. In effect, usable objects were efficiently decommissioned prior to burial.

The presence of cauldron fragments demonstrates that they were ascribed social significance beyond functional usefulness as their social 'lives' were extended and they took on different meanings associated with the cauldron pit and its contents. Perhaps fragments were intended to stand for complete cauldrons (see Chapman 2000; Chapman and Gaydarska 2007), or possibly these cauldrons were 'unmade' immediately prior to deposition with the remaining parts recycled or taken away and deposited elsewhere. The inclusion in the hoard of cauldrons with different techniques of manufacture (Chapter 6) may be inadvertent but it could also indicate that it was important that a representative sample of the cauldrons in circulation at the time was included in the deposit.

Cattle skulls

At one level, the selection and inclusion of the two cattle skulls (probably from bulls), deposited in the southern part of the pit, could be seen to represent the foods consumed in the cauldrons; but examination by Lorrain Higbee (Chapter 7) also revealed a series of faint cut marks on both skulls, which she interpreted as evidence for skinning. Although the skulls are generally well preserved, parts of the upper jaw and all but one of the teeth of both are missing. None of these absent parts were recovered from the pit, which suggests that damage occurred prior to deposition. Higbee interprets this as evidence that the skulls may have been stored or displayed for some time before they were placed in the pit.

Similar evidence indicating the possible display of cattle and horse skulls has been discovered elsewhere in the region. At Battlesbury Bowl, Wiltshire, seven cattle and three horse skulls were deposited together in a ditch dating to the Middle Iron Age (Hambleton and Maltby 2008; Hambleton 2013). Most of the skulls lacked teeth and had been deliberately modified to expose the brain cases. Some had also been carefully skinned and cleaned. As Hambleton explained, 'this combination of taphonomic markers could support the suggestion that these were prepared skulls, which were left exposed for some time, perhaps as objects of display, and may have served as some form of (symbolic) markers before they were finally deposited in the ditch' (Hambleton 2013, 489). At High Post, near Salisbury, Wiltshire, a cattle skull showed evidence for skinning and was missing teeth and parts of the skull (Higbee in Powell 2011, 77). Elsewhere, two horse skulls placed at the terminal of an enclosure ditch at Farmoor, Oxfordshire (Lambrick and Robinson 1979, 23–4), have been interpreted as having been displayed before they were deposited (Wilson 1999, 302). Could the cattle skulls from the Chiseldon hoard have marked the location of deposition or acted as markers for the setting of a significant social gathering?

Explanations drawn from the ethnographic literature as to why animal skulls were displayed range from their use as fertility symbols to warding off evil spirits (see Wilson 1999, 299–300). These may serve as possible reasons why animal skulls were displayed during Middle Iron Age Wiltshire, but given the association in the Chiseldon pit between displayed cattle skulls and cauldrons, the possibility also remains that the skulls originated from animals sacrificed at feasts. There is a widespread tradition throughout Southeast Asia, for

example, in which the sponsor of feasts commemorates significant events by displaying parts of sacrificed animals as trophies (Clarke 2001, 160; Hayden 2014, fig. 6.10). The evidence from Chiseldon could, therefore, be suggestive of a wider regional tradition of displaying parts of animals sacrificed at feasts as trophies at Middle Iron Age sites in Wiltshire. In the case of the Battlesbury Bowl and Chemring remains, they became incorporated into other types of deposit after having had a previous 'life' as display objects (Hambleton 2013, 492). At Chiseldon the connection with feasting was more directly maintained in deposition.

Interpreting the arrangement and contents of the hoard

A number of processes then are made visible through detailed consideration of the cauldrons. Decommissioned, but nearly complete, cauldrons were initially placed at the outer limits of the pit. Their intactness appears to contrast markedly with the method used to dispose of the majority of cauldrons – dismantling for recycling and/or the deposition of fragments (Joy 2014). But many of these seemingly complete cauldrons were rendered unusable, probably at or close to the time of deposition. Stacking of cauldrons towards the centre may be due to limited space in the pit but it could also reference the way in which cauldrons were presumably stored when not in use; placed rim side down or leaning on their sides so as to prevent the bowl collapsing under the weight of the rim. The inclusion of cauldron fragments in the pit could represent the stages of disintegration and recycling more usually associated with cauldron disposal but in this instance they have been re-incorporated into the deposit. It is impossible to determine how much time elapsed between the break-up of the fragmentary cauldrons and their eventual deposition, but it is possible the fragments were curated for some time (see Joy 2016). The cattle skulls could also have been displayed elsewhere before they were placed in the hoard pit but if so, their good condition suggests that this was not for very long.

The presence of wear and multiphase patching demonstrates that many cauldrons were extensively used before they were deposited (see above). They were, therefore, not made especially for deposition and could have been in circulation for many years, probably decades. Patterns of wear compare well with those seen on other cauldrons (Joy 2014) suggesting that there is nothing remarkable about the undecorated Chiseldon cauldrons in the pit other than the context of their deposition. Perhaps their significance was acquired throughout their lives and they were what Marshall has termed 'lived' objects (Marshall 2008, 63), selected because of their participation at specific social gatherings, or perhaps because they were linked to particular individuals, groups, places or events. Cauldron fragments could have been curated and selected for deposition for similar reasons. The selection and inclusion of decorated objects in the deposit is noteworthy because of their rarity (Joy 2014). They can be contrasted with undecorated examples because their significance was marked out or 'inscribed' (Marshall 2008) into them at the time of their production through their decorations. Their presence in a highly unusual deposit served to underline its distinctiveness.

The nature of the activities represented by the Chiseldon deposit

As outlined in the introduction to this chapter, it is argued that the Chiseldon hoard could represent (either directly or symbolically) some form of feasting event, or series of events, with the cattle skulls illustrative of the meat consumed at the feast. Owing to their scarcity, large size and complicated manufacture, Joy (2014, 342) argued that cauldrons were not used every day but were rather especially made for the preparation and serving of food or drink at larger social gatherings, probably feasts. The importance of feasting to Iron Age society has been increasingly recognised (e.g. Dietler 1996; Arnold 1999; Dietler 2001; Ralph 2005; 2007). It can be defined as the ritual consumption of food and drink (Dietler and Hayden 2001a, 3) and is viewed as having a critical role in maintaining and renegotiating relationships, both between and within communities (e.g. Dietler and Hayden 2001a; 2001b).

Large social gatherings are seen in earlier periods of prehistory, such as at Neolithic causewayed enclosures where animal remains have been discovered in large quantities (Thomas 1991, 23–9). Evidence for large-scale feasting is also apparent during the Late Iron Age at sites such as Brisley Farm, Kent (Stevenson 2013) and Hallaton, Leicestershire (Score 2011), but it has hitherto been less well recognised during the Middle Iron Age despite good evidence to indicate it was an important activity. The dating of the Chiseldon deposit to the Middle Iron Age draws attention to the existence of large-scale feasting in Britain during the Middle Iron Age; but before this is further discussed, it is first important to summarise the evidence for feasting in Iron Age Wessex.

Feasting in Wessex

There is extensive evidence for feasting in the Wessex region throughout the Iron Age, including feasting residues such as large quantities of animal bones (e.g. Powell 2011). It is difficult to reconstruct prehistoric feasting practices in detail because of the limitations of archaeological evidence (Dietler and Hayden 2001a, 5); consequently, studies have focused on single sites, rather than reconstructing feasting complexes (Madgwick and Mulville 2015, 630). A notable exception is the tradition of Late Bronze Age and Early Iron Age middens (c. 900–600 BC), which form some of the best evidence for feasting in British prehistory (McOmish 1996; Needham and Spence 1997; Lawson 2000; Lodwick and Gwilt 2011). These are found in southern Britain and contain huge quantities of material, including ceramic and bone fragments, metal, bone and stone objects and sometimes even human bone. Middens vary widely in terms of their depositional histories and composition (Madgwick 2016), but they are generally viewed as providing evidence for communal consumption on a vast scale (see Madgwick and Mulville 2015, 630). The middens are generally linked to new social structures following the breakdown of elite practices centred on the exchange and deposition of bronze metalwork (Needham 2007). For example, based on detailed examination of the faunal assemblage from the midden at Llanmaes, South Wales, Madgwick and Mulville (2015) proposed the great middens represented community-focused

events meant to cement social relations at a time of social upheaval. It is worth quoting them at length:

All participants would have been involved in the ritual of travelling to Llanmaes with pigs in tow, slaughtering, processing, consuming, destroying, depositing and redistributing in a socially circumscribed manner. The division of pigs from across the landscape and their redistribution to different areas would have provided a strong symbol of community unity, and, along with the shared experience of the feast, would have been a potent force in generating a collective consciousness in a disparate populous. (Madgwick and Mulville 2015, 641)

Middens go out of use by the 6th century BC but widespread evidence for feasting continues, albeit on a reduced scale. For instance, Hill (1995b) identified deposits of well-preserved animal bones and pottery fragments possibly representing the remains of feasts such as pit 6595 at Winnall Down, which he argued provided evidence for a communal feast involving the sacrifice and consumption of more than 12 cattle as well as horses, a sheep, pig and hare (Hill 1995b, 127). Feasts such as this could have been planned several years in advance and involved cooperation between groups. Livestock were raised or kept alive for the feast and additional cooking and serving vessels were required. As was also implied by Madgwick and Mulville (2015) in their discussion of the finds from Llanmaes, attendees at the feast may have travelled for long distances bringing their animals and crockery with them (Hill 1995b, 127).

An extensive deposit of animal bone dated to the 5th century BC was also discovered at High Post near Salisbury, Wiltshire (Powell 2011). Extending up to 15m it contained the remains of a minimum of 32 animals (25 cattle, 5 sheep, a pig and a horse), providing an estimated 7,450kg of meat. This spread of bone was possibly related to the boundary of a settlement. A further pit from the site contained over 12.3kg of animal bones, most of which were articulated. Powell (2011, 94) interpreted the large spread of animal bones as a 'foundation deposit' and saw a sequence of events that involved their slaughter/sacrifice, partial consumption through feasting (much meat was left on the bone) and the laying out of selected bits of animal below the defensive bank of the enclosure. Even though the meat from the animals was only partially consumed, the remains from High Post imply feasting on a large scale, possibly linked to the construction of the enclosure.

Storage pits more generally, which are pervasive across all types of settlement in Wessex but especially hillforts, have also been suggested as evidence for feasting (Van der Veen and Jones 2006; Jones 2007; Van der Veen 2007). The standard interpretation of these pits is that they were used to store grain (Wood 2000, 99) and many researchers have argued they were a means of preserving seed corn for springtime sowing. This interpretation has recently been contested (e.g. Van der Veen and Jones 2006) because one of the crops most often found in storage pits, spelt wheat, is best suited to autumn sowing, meaning that long-term storage of seed grain would be unnecessary. An alternative interpretation for storage pits is that they were used to store grain to be consumed at feasts (Van der Veen and Jones 2006; Jones 2007; Van der Veen 2007). Taking a long-term

view following changes in the morphology and usage of hillforts, Van der Veen and Jones (2006) argued hillforts acted as foci for social interaction and surpluses of grain were stored for occasional large communal gatherings such as 'work-party' feasts, intended to reward individuals working to modify the ramparts of developed hillforts (see also Sharples 2010).

A second analysis of storage pits examined in detail potential feasting activities at Danebury hillfort (Jones 2007). Based on an estimate of a total number of 3,600 pits at the site, which was occupied for approximately 450 years, Martin Jones (2007, 148) argued there was an average of eight feasts per year. These estimates were founded on the size of pits and estimates of the consumption of food and beer. Jones recognised three types of feast from the archaeological data (see below for alternative types of feast as defined by Dietler). The contents of the majority of the pits at Danebury provided sufficient food to accommodate a week-long feast with 170 attendees. Five percent of the pits were roughly double that size and could provide for twice as many people. The frequency of these 'middle-sized' feasts was perhaps once every three years. A final 'super-pit' supplied enough food for 500 people for one week. Feasts on this scale occurred once every 25 years. These are clearly rough estimates and do not account for the consumption of other foods, particularly meat. Feasts could also draw upon the contents of more than one pit. Nevertheless, even if only some of the storage pits at Danebury contained food for feasts, it highlights the potential scale of feasting activities and the continuation of the importance of agricultural produce as a possible means of pooling labour, perhaps to construct hillfort boundaries, and to facilitate large social gatherings.

In summary, Late Bronze Age and Early Iron Age feasting middens went out of use by the 6th century BC but feasting debris found at settlement sites and evidence derived from grain storage pits demonstrate feasting persisted in a different pattern and was a regular activity. Both Hill and Jones uncovered evidence for large-scale feasting events, involving substantial groups of people and communities, with individuals potentially travelling long distances to attend. Feasting on the scale implied by the remains found at Danebury and High Post implies that events required a great deal of planning and cooperation between communities and households. These feasts probably performed critical roles in the regeneration of society (e.g. Hill 1995b) and many can be linked to the period of the remodelling of developed hillforts which was largely completed in the region by the end of the 3rd century BC (Sharples 2010, 136) (see above).

The Chiseldon feast?

Although the cauldrons and cattle skulls found at Chiseldon are suggestive of the physical remains of a large feast, it remains to be demonstrated that they have more in common than their final deposition context (see Pappa *et al.* 2004, 24). In considering the nature of the Chiseldon deposit, it is informative to question not only what is represented in the pit but also what is not there. Other than the cattle skulls, which appear to have been displayed before deposition, the only other animal remains are much degraded and were

probably included accidentally as part of the pit backfill. This means that the animal bones that we might expect, which have been discovered at other identified feasting sites (Ménier 2001, ch. 2) (see above), are missing. Cartwright and Ryan (Chapter 10) discovered wood remains that could indicate the presence of wooden serving vessels and other artefacts such as lids, which unfortunately no longer survive. Nevertheless, considering the possible numbers of people fed if so many cauldrons were used simultaneously, these wooden remains could not possibly account for all the serving vessels required. Similarly, the insignificant quantity of pottery recovered from the pit was in the form of small, highly degraded sherds likely to have been accidentally incorporated into the backfill. Given such a large gathering as appears to be suggested by the number of cauldrons (see below), it seems highly unlikely that no ceramics were used at feasting events.

On the balance of probabilities, therefore, the Chiseldon deposit is more likely to be symbolic of a feast, or series of feasts, rather than representing the physical remains of a single event that took place at the location of deposition. At the most, the deposit is only partially representative and does not include all of the food remains and paraphernalia necessary for such a large feast such as serving dishes and cauldron chains for example. This conclusion raises a number of interesting questions. If the deposit is merely symbolic and not a complete representation of a specific event, did the event or series of events it refers to take place at Chiseldon, or was the location of the hoard chosen for some other reason, perhaps its accessibility or proximity to important features in the landscape (see above)?

What did they eat?

Steele's (Chapter 9) analysis of the food residues found adhering to the Chiseldon vessels provides the best indication we have to date of the types of food prepared and served in prehistoric cauldrons. The presence of heated organic material indicates they were used for cooking, not just for serving food. This is confirmed by the sooty deposits found on the outside of the cauldrons implying that heating was achieved through suspension over a fire.

Owing to the fact that they are seldom discovered, few food remains adhering to prehistoric metal vessels have been analysed. The giant Greek cauldron with a capacity of around 500 litres from the well-known late Hallstatt (540–520 BC) grave at Hochdorf, southwest Germany contained honey pollen residues indicating that it was last used to serve a honey-based beverage, most probably mead (Biel *et al.* 1985; Koch 2003, 132). Two metal jugs from separate early La Tène graves (450–400 BC) found at the Glauberg, Hesse, Germany also contained residues derived from honey-based drinks (Bartel *et al.* 1998; Koch 2003, 133–5). Alongside Hochdorf, they demonstrate the probable significance of mead in the region during the late Hallstatt and early La Tène periods. Rich cremation burials containing, among other things, buckets and wine amphorae (Stead 1967; Stead and Rigby 1986; Fitzpatrick 2009) also provide evidence for the significance of the consumption of alcohol in southern England during the Late Iron Age (Fitzpatrick 1985; Loughton 2009).

During the Late Bronze Age, specialist feasting equipment such as bronze cauldrons, flesh-hooks and spits were in use throughout central and northern Europe, Italy and the Atlantic coast, including Britain, Ireland, western France and Iberia (Gomez de Soto 1993; Needham and Bowman 2005; Gerloff 2010; Armada 2011). These objects have been linked to the consumption of meat at feasts as well as alcohol (Armada 2011, 168). In 2005 a small sample of black material from inside the rim of one of these Late Bronze Age cauldrons from Feltwell, Norfolk, was examined by Rebecca Stacey of the Department of Conservation and Scientific Research at the British Museum and was found to contain animal fat (Stacey 2005). Like the food residues from the Chiseldon cauldrons, the black material was some kind of food residue containing meat.

Steele's analyses identified three groups of residues adhering to the Chiseldon cauldrons: those containing large quantities of animal fat; those that were less fatty; and those with no fat at all. When combined with evidence for the presence of plant remains, probably vegetables or grains, and the possible occurrence of ruminant milk fat, it is probable that the cauldrons were used not only to cook meat (cow, sheep or goat) stews but also other dishes containing only plant material, or a mixture of meat and plant material, such as soup, porridge or gruel. These findings are not only significant for interpreting the Chiseldon hoard, but also show that Middle Iron Age feasting in southern England was probably primarily meat-based, rather than having an emphasis on the consumption of alcohol as was the case on the Continent during the Early and Late Iron Age and during the Late Iron Age in southern Britain. The identification of multiple dishes also extends the known culinary repertoire served in cauldrons beyond meat stews.

Potential number of participants

Any detailed attempt to estimate the number of potential participants at a feast based on the average capacity of the cauldrons risks creating a false impression of accuracy, especially as it is very difficult to establish how much an 'average' person ate and it is impossible to determine how many servings of food were prepared in each vessel at any given event. Nevertheless, this is a necessary risk because it is important to understand the potential scale of activity the Chiseldon remains might represent even though it is not thought likely that a single event is represented at Chiseldon. Joy (2014, table 4) calculated the average volume of IA/ER cauldrons to be somewhere between 40 and 50 litres. Reckoning the volumes of cauldrons is challenging because their profiles are so different and their size and shape make accurate measurement difficult. Comparing Joy's estimates with those made for the Chiseldon cauldrons, it seems that the model used by Joy may have underestimated the volume of larger cauldrons and overestimated the volume of smaller examples. For example, the volume of eight of the 17 complete cauldrons from Chiseldon could be calculated (calculated by modelling the volume of the bowl as half that of a sphere ($V = (4/3\pi r^3)/2$) and adding this value to the volume of the upper section which is approximated as the volume of a cylinder ($V = \pi r^2 h$)). These show a larger variation than that noted by Joy (2014, fig. 8), ranging from

Cauldron	Volume (Litres)
3	60
4	63
9	70
11	74
12	34
14	15
15	33
16	22

Table 15 Volume of cauldrons (in litres)

15 to 74 litres (see **Fig. 102; Table 15**). Despite these discrepancies, the average volume of the Chiseldon cauldrons is around 46 litres. This corresponds well with Joy's figures. Scaling this figure up, excluding the cauldron fragments, if all the complete and nearly complete cauldrons were used at the same time, they had a total capacity of nearly 800 litres. Given they are unlikely to have been filled to the brim, at three-quarters full their total capacity was nearly 600 litres. Iron Age cattle could yield up to 200kg of edible meat (McCormick 2009, 405), so the meat from the two cattle represented by the skulls in the pit at Chiseldon therefore would amply supply the 17 cauldrons when supplemented with vegetables, grains and other ingredients for stews, porridges and gruels.

The scale of consumption at feasts recorded in the ethnographic literature can be truly astounding in terms of the number of participants and the quantity of food consumed. Although he cautions that the numbers were probably exaggerated, Thomas (1990, 95) noted that some reports of Marquesan Island feasts listed up to 10,000 participants. Documenting feasts in Papua New Guinea, Feil (1987, 249) noted that at some ceremonies up to 11–13 pounds (4.99–5.89kg) of meat was consumed by each person, but this was over an extended period with multiple servings. This means theoretically that the meat from the cattle represented by the two skulls in the Chiseldon hoard may have been consumed by only 80 individuals. This seems unlikely. Assuming the cauldrons were used simultaneously and that each person in attendance consumed half a litre of stew, around 1,200 people could be fed at the same time using only the complete cauldrons from the pit. If people had bigger appetites and each person consumed an average of 1 litre of stew, it still suggests 600 participants. Looking more broadly at ethnographic examples (see Hayden 2014), vessels can be used many times to prepare different dishes and feasts can continue for days. Even if, as we suspect, the objects from Chiseldon do not represent the physical remains of a specific event, they indicate the capacity within society at the time to host such ceremonies: events accommodating hundreds if not thousands of participants. The animal remains from High Post could also point to other Middle Iron Age feasting activities in the region on a similar scale to those identified at Chiseldon.

Context of consumption

What kind of social group might a gathering of between 600–1,200 individuals have represented? Spielmann's (2002)

definition of a small-scale society may be useful here, meaning a society '...ranging from several hundred to several thousand people in size and characterised by relatively uncentralised political systems' (Spielmann 2002, 195). This also fits well with Hill's (2011) summation of a 'typical' Middle Iron Age 'community' which is worth quoting at length:

Clusters of dispersed households or a larger single settlement probably intensively exploited a territory rarely larger than 5–8km across. Local communities may have had perhaps *c.* 100–200 members, with *c.* 30–40 adult men (using population densities from early medieval Europe as a rough guide). If topography allowed these communities may have been combined into larger clusters of communities, or, in the case of some 'developed hillforts' and 'villages' etc., a single co-resident community; although, the territories of these community clusters might rarely have been larger than *c.* 15–20km across – and sometimes surrounded by areas of little or no permanent settlement. Many communities may have also regularly used resources (pasture, woodlands, mineral sources, salterns, etc.) longer distances away through transhumance and other seasonal and irregular travel. These clusters of communities may have only had populations of a few thousands with 200–400 adult men. (Hill 2011, 250)

Following Hill's and Spielmann's different terminology, the total feasting capacity represented by the Chiseldon remains could represent a gathering on the scale of a 'small-scale society', or in Hill's categorisation a 'cluster of communities'. But it is argued here that rather than getting too bogged down in deciding if a community should be defined as 'this or that', we should instead examine moments in the archaeological record where a community of humans (and non-humans) is clearly defined. The Chiseldon hoard is just such an instance as it makes manifest a large social gathering, whether symbolic or real.

In addition to the potential feasting patterns recognised by Martin Jones and discussed earlier, Michael Dietler (1996; 2001) identified three different feasting patterns, which are useful in terms of understanding the types of activity possibly represented by particular archaeological remains (see Dietler 1996, 107–15; Poux 2004; Ralph 2007, 85; Fitzpatrick 2009). 'Entrepreneurial' or 'empowering' feasts provide a means to acquire influence or prestige in societies lacking fixed social hierarchies or formalised political roles. This feasting pattern also includes those conceived of and presented as celebrations of community identity (Dietler 2001, 76–7). 'Patron-role' is a term used to describe feasts where there is no expectation for equal reciprocation. These types of event occur in hierarchical societies that are in part supported or generated by an obligation on the part of the social elite to host feasts. The final pattern of feast, 'diacritical', describes the use of different styles of food and drink and ways of consuming them to reinforce social difference. This type of feasting creates what Appadurai (1986, 21) termed 'tournaments of value', defining the membership and parameters of competition among a social elite. Diacritical feasting is prone to emulation as special foods, methods of consumption and feasting paraphernalia were often copied by the lower classes (Dietler 2001, 86).

The presence of cauldrons and other feasting equipment in richly furnished late Hallstatt and early La Tène

Continental graves and 1st-century BC cremation burials in southern England has been interpreted as evidence that the grave occupants were, or represented the hosts of, ‘patron-role’ pattern feasts (Fitzpatrick 2009, 395). Consequently, if the Chiseldon cauldrons had been discovered in a context where there was clear evidence for established social hierarchies, the number of vessels and therefore the potential scale of commensality they represent, as well as the quality of the cauldrons’ manufacture, would probably lend them to being viewed as evidence for patron-role feasting. On current evidence, the archaeological record does not support this interpretation, but it is always possible that future excavation at sites such as Barbury Castle could provide evidence for distinct social hierarchies. Given that all of the vessels are fairly similar, and there is only evidence for the consumption of dishes using relatively commonplace ingredients, albeit dishes probably containing far more meat than was normal, there is no indication of diacritical pattern feasting. So almost by default therefore, the Chiseldon hoard probably represents evidence for ‘empowering’ feasting, as do other Middle Iron Age deposits such as those already discussed from High Post.

It is always difficult to match general categories to specific case studies and it is questionable exactly how useful general categories are. Nevertheless, both Jones’s and particularly Dietler’s categories provide a useful indicator of the type of feast represented by the Chiseldon assemblage and the possible motivations behind feasting events. Dietler (2001, 76–82) suggested that the primary motivation for empowering feasts was the acquisition of symbolic capital and the creation and maintenance of social relationships. Much emphasis on the social significance of feasting has focused on the ways in which individuals and groups can gain prestige by outcompeting their rivals with the lavishness of their feasts (e.g. Boas 1966), but in small-scale societies made up of small households like those in Wessex during the Middle Iron Age, restrictions and taboos are often placed over overt self-aggrandisement (Wiessner 1996, 11). Nevertheless, as Spielmann argued (2002), communal gatherings such as feasts can have all kinds of social benefits through the act of bringing people together: ‘thus, feasting and craft production in small-scale societies are supported not by elites but by numerous individuals as they fulfil ritual obligations and create and sustain social relations’ (Spielmann 2002, 197). Perhaps in this instance, at a time where communities were preoccupied with constructing physical boundaries in the landscape, feasting played a critical role in bringing people together, whether for major construction projects or activities related to the maintenance of a society primarily made up of small households. Rather than serving as a means of the personal aggrandisement of competitive individuals, feasts at this time served as a critical means of endorsing and renegotiating group identity.

If feasting was so important why aren’t there more cauldrons?

One last question remains: if feasting was so important and cauldrons played such a significant role, why is there not more evidence for cauldrons in the archaeological record? There are probably a number of factors. First, as we have

seen, archaeological evidence for feasting is widespread, indicating it was an important activity. Linked to this, evidence from slightly later in the Iron Age shows that sheet metal probably from cauldrons was being processed for recycling (Joy 2014, 342–3). We should therefore assume that the expected end of a typical cauldron life cycle was to be broken up and recycled, not to be deposited in more archaeologically visible contexts (Joy 2014, 343). The cauldrons we encounter in the archaeological record can be classified, then, as ‘odd’ or ‘non-typical’. Extensive use-wear shows that many cauldrons had long use-lives (see also Joy 2014). They could also be reused at many different events, so perhaps relatively few were required to maintain a significant ceremonial tradition. Finally, evidence from small-scale societies elsewhere shows that socially valued goods are likely to be passed on to the next generation, meaning that they rarely enter the archaeological record (Spielmann 2002, 202).

Interpreting the hoard

Pulling all of the information presented in this chapter together, the majority of the population in the vicinity of the location of the Chiseldon hoard probably lived in small households. Their day-to-day lives centred on the farmstead, growing crops and rearing livestock. Each farmstead controlled a parcel of land, with larger groups sharing resources such as communal pasture and woodland. The hoard may have been buried in or near to one such farmstead. At this time a larger group of people may have also occupied the hillfort at Barbury. There is scant evidence for craft specialisation and status indicators such as richly furnished graves or houses significantly larger than others are also absent from the archaeological record. It is likely therefore that social hierarchies were relatively flat. This is not to say that there was not competition between individuals and between households, just that there was not a stable group of elites controlling production and resources as is implied by the hillfort model of society.

One interpretation of the Chiseldon deposit could be that it represents an act of conspicuous destruction, perhaps as an offering or a display of community wealth. But the fact that many of the artefacts were damaged (possibly deliberately) prior to deposition may indicate that, through their deposition, their use was also being ceremonially brought to an end. Looking specifically at funerary practice and burial, Hamilakis has argued that during the performance of burial ‘what is “killed” ... is not the memory of the person itself, but the memory of the social person as player and participant in the construction of social experience’ (Hamilakis 1998, 117). In addition to providing a forum for mourning and the celebration of a life, the performance of burial and the funerary rituals accompanying it also create new ‘social’ space for living people to occupy. Perhaps we can see something similar in the Chiseldon hoard. The collection and deposition of such large numbers of cauldrons in a single pit is unique. The inclusion of highly unusual decorated objects underlines its individuality. At the same time, by including different types of cauldrons sharing techniques of manufacture, a representative sample of the cauldrons in circulation at the time was selected and incorporated into

the deposit. The cattle skulls may represent meat consumed in the cauldrons at a feast and were displayed as trophies. The undecorated cauldrons and cauldron fragments could have been selected because they were used in, or stood for vessels present at, particularly important events. Different arrangements within the pit, such as the stacking up of cauldrons near the centre, may also reference stages in the typical life of a cauldron, in this instance storage. Likewise, cauldron fragments denote the typical end or 'death' of cauldrons: their dismantlement prior to being recycled.

The Chiseldon hoard was probably deposited in a small settlement, a convenient gathering point located close to notable places in the landscape, and it is possible that large groups of people gathered together there for specific events. Alternatively, its significance may solely relate to deposition. The hoard represents a 'snapshot' or a 'time trap' of the networks of people, places and things embodied in the collection and accumulation of these artefacts (see Garrow and Gosden 2012, 156; Wingfield 2013, 80; Joy 2016). Evidence for use and repair evident on the cauldrons suggests the activities referenced did not necessarily all occur immediately prior to deposition. The selection and incorporation of cauldron fragments into the deposit also underlines this point and may indicate that what is being represented by the hoard is a series of events, possibly of some long standing. The contents of the hoard may have also taken some time to gather and collect, a process that could have been undertaken by several individuals or groups. Excavation evidence indicates the pit was filled in one episode but, because of the quantity and quality of objects represented in the hoard, it may have taken time and collaboration between individuals and groups to select and collect the material prior to deposition. The display of the cattle skulls as trophies perhaps marked the place where the objects were collected, or possibly even displayed for a short time, prior to deposition.

The hoard represented activities beyond any 'average' consumption by the local resident households. Rather, participants at a feast on the scale embodied by the Chiseldon hoard probably drew on larger groups of the sorts discussed by Hill and Spielmann (see above and also Pappa *et al.* 2004, 38–40). Food could have been prepared and presented for wider consumption by individual 'family' or 'household' units who each possessed a small number of cauldrons, perhaps reserved for this special purpose. The relatively standardised size and form of the vessels is also suggestive of a wider significance, possibly related to the capacity of such groups to contribute to feasting events. The Chiseldon remains, therefore, hint at a number of different scales of commensality including the household or family kin group, local and wider regional groups. At each level, the preparation and consumption of food would have provided opportunities and forums to maintain and cement relationships, as well as an arena for competition between individuals and groups (Pappa *et al.* 2004; Hayden 2014). Relationships between communities or groups may have been difficult in some instances, particularly in terms of access to key resources. A social gathering, such as a feast represented actually and/or symbolically through the Chiseldon deposit, could have acted like a 'social glue',

bringing people together and enabling cross-community interaction (see essays in Dietler and Hayden 2001b; and Wiessner and Schiefenhövel 1996). Communal gatherings were necessary as a forum for social negotiations and transactions, as well as for social wrangling both between and within groups to agree marriages, conduct rituals, pass judgements and exchange goods (Karl 2008, 75).

The deposition of the Chiseldon hoard coincides with a period when some hillforts were modified or developed and people may have come together to help in these construction projects (Sharples 2010). The focus at this time on constructing fortified sites and boundary earthworks suggests a concern with defining the extent of bounded communities, with an emphasis on group membership and communal identity. Boundary construction was therefore a means by which the relative status of local groups was negotiated. Feasting, or the ritual consumption of food and drink, probably formed an important arena for these activities and events. Is it coincidental that the hoard was deposited at this time and does it relate to the emergence of developed hillforts such as Barbury Castle? Two scenarios present themselves. In one scenario, we can see the Chiseldon hoard as evidence to confirm Sharples's (2010) argument that feasts were crucial in the process of pooling and organising labour in order to create and rebuild boundaries and the defences of hillforts. In the second, this careful and very deliberate deposit could have been intended instead to mark the end of a particular social gathering, or long-standing series of events, creating the social space for new activities such as boundary construction to occur.

The emphasis on burying the Chiseldon hoard as a single deposit, possibly as an offering of some kind, also could be symbolic of the fact that this was a communal event with many members of the community present; just as many individuals were presumably involved in the work necessary to produce a surplus to host the feast or feasts the hoard was intended to represent. Ritual at this time was, therefore, probably communal and not dominated by powerful individuals. One of the problems with economic or political models such as the hillfort model of Iron Age society is they tend to ignore ritual and its significance in terms of economic production (Spielmann 2002, 195). Communal and individual participation in ritual performance is not necessarily always restricted to small sections of the population and, where entire populations are involved in regular communal and individual ritual obligations such as feasting events, as we think the Chiseldon deposit exemplifies, it can also act as a driver for economic activities such as the production of surplus food and the manufacture of feasting equipment. Brian Hayden (2014, 211) recently argued that because feasting affords a forum for social transactions between multiple kinship groups, or factions, it could also have the effect of fuelling the need for specialised material culture such as large vessels to prepare and serve food and drink. Although it is a vastly different social context, the efforts of Ongka, a charismatic 'Big Man' of the Kawelka tribe of the Papua New Guinean Western highlands, to arrange his 'Big Moka', or ceremonial gift exchange of 600 pigs, some cows, a motorcycle, a truck and money, demonstrate the huge individual and collective effort

required to create a surplus, raise and feed animals, and provide gifts (Nairn 1981): activities all related to large feasting events. Planning for a feast on the scale represented by the Chiseldon hoard is likely also to have been very time-consuming and probably required considerable sacrifices to be made by the organising community. It is therefore argued that just as elites may sponsor the manufacture of specialist feasting equipment (an economy of elites), so too can production of special artefacts be required to meet the demands of a ritual mode of production. As Spielmann (2002) succinctly expressed it, 'ritual does not simply regulate work; it demands work' (Spielmann 2002, 197). Food preparation for feasting created a demand for special cooking vessels, in this instance metal cauldrons. Cauldrons were a familiar artefact form used in the Bronze Age where they were possibly linked to elite identities, but they took on a new significance as communal feasting vessels in Middle Iron Age Wessex. Feasting therefore provided the social need to manufacture cauldrons. Since cauldrons were long-lived, then so too was feasting an important and enduring social practice.

Chiseldon and its legacy with Alexandra Baldwin

There can be few discoveries of the importance of the Chiseldon hoard that met with such little initial enthusiasm. The size of the find and its uncertain date (and therefore its tentative classification as a Treasure case) failed to excite those who knew of the discovery and it was only as a result of pressure from the finder, Peter Hyams, that the hoard was investigated and recovered. Even when the dating became certain it is probable that the reluctance of heritage professionals who were aware of the discovery to investigate it further was due to issues of resources and acquisition of funding for preserving what is an unglamorous find. Yet the results that have been obtained from the careful excavation of the objects and their subsequent scientific examination have shown it to be an unprecedented and important discovery. In the final section of this chapter we assess some of the problems we encountered and the potential legacies of the project.

Challenges posed by the project

The primary challenges encountered during the course of the project related to the large number and poor condition of the cauldrons. The time delay between the discovery and conservation of Treasure finds raised further issues. Conservation of finds prior to valuation (apart from some preventive measures such as repacking or controlling the environment) is only allowed within the Treasure Act to aid identification of the find and therefore only routinely occurs for coins, where detail of the legend or mint mark is required. In many instances no conservation is carried out until the find is acquired. Only if and when a group of objects have passed through the Treasure process and been acquired by a museum can funding for post-excavation work be sought and remedial conservation work be carried out. For complex and fragile assemblages such as Chiseldon the delay between discovery and conservation can be too long. For the Chiseldon cauldrons the period between excavation

and acquisition was three years, during which time the condition of the metal had deteriorated significantly.

Accurately estimating the time required to conserve a group of objects lifted in blocks when their exact condition and number is unknown is also virtually impossible. Before the start of the project one cauldron was conserved to estimate the time and resources required, but we could not have anticipated the discovery of five extra cauldrons within the assemblage which were invisible because they were stacked inside other vessels. We also failed to fully anticipate the deterioration in the condition of the cauldrons over time. The rapid corrosion and embrittlement of the metal after excavation, especially the copper alloy components, was noted during the conservation of the trial cauldron; however, it was hoped that many of the cauldrons yet to be excavated would be in a less fragmentary condition. Sadly, all were in a worse condition with structurally weaker metal.

It was recognised from the outset of the project that not all of the objects would be conserved to the same standard, with a few examples being conserved to display level while others would be conserved to enable only essential information to be retrieved. In reality none of the vessels were conserved to an ideal standard for display owing to their inherent weaknesses, and many of those that were to be conserved to a lesser extent required much more reconstruction work than anticipated. More extensive conservation was needed in order not to lose the relationship of the hundreds of tiny fragments to each other and to maintain the readability of the objects for any further study. But full reconstruction of large areas of the sheet metal would have led to collapse and strain and required extensive backings and facings to support the weight of the vessel, destroying their research potential. The level of conservation was therefore largely a compromise between legibility and stability.

The requirement of future researchers to access the cauldrons both physically and intellectually was kept in mind throughout the project. The need for access, while paramount, has to be weighed against the condition of the artefacts. The objects even after conservation remain extremely fragile and their handling should be restricted. Future researchers will still be faced with the difficulties of interpreting and identifying the fragments and will have to rely heavily on the documentation generated by this project. Because of these challenges fully documenting the fragments during the project was foremost in our minds, from recording the location of the individual fragments within the soil blocks during excavation, to providing meaningful virtual reconstructions of the cauldrons. Again this was made more complex by the extremely fragile state of the cauldrons and the need to keep handling to a minimum, as well as the requirement for rapid documentation methods which would not hold up the excavation of the blocks.

Some unexpected findings

Alongside these challenges, the project also presented opportunities and it is an excellent case study of a highly complex multi-disciplinary project showcasing the work of Wessex Archaeology, the British Museum and the Treasure and Portable Antiquities Scheme. It involved direct



Figure 106 Conservators treating the cauldrons as part of the 'Conservation in Focus' exhibition in 2008

collaboration between staff at Wessex Archaeology and the British Museum, reinforcing existing links. It also enabled archaeologists to gain experience of a large complex lift and provided British Museum conservators with an opportunity to refresh their on-site archaeological work. The presence of conservation specialists during the excavation process is rare, but essential for lifting complex or fragile finds. Trying to unravel the complexities of the finds from Chiseldon would have been very difficult had we been solely reliant on the site drawings and photographs, and personal knowledge of the finds from the excavation was extremely important to this project. The project also enabled the development of skills required to manage a large project from excavation to publication. It provided a highly complex set of archaeological objects to work on for several years, with material for numerous lectures and teaching courses.

The amount of information retrieved from the cauldrons throughout the course of the project also exceeded all expectations, and although the condition of the artefacts was far from perfect, important details concerning their technology and use were discovered. As was outlined at the beginning of this chapter, this information has transformed our understanding of cauldrons: an important class of prehistoric vessel. Analysis of organic residues on metal artefacts is generally not carried out, or even considered, because the level of preservation of the residues required for analysis is not usually present on non-porous metallic surfaces. But in the case of the Chiseldon cauldrons the food residues were so thick and well preserved that analysis gave positive results from all the samples taken. The preservation of the cauldrons, despite being highly fragmentary and

fragile, was otherwise remarkable. The deposit in a clay-rich soil must have provided a largely anoxic environment greatly reducing the amount of corrosion of the metal in the ground. It is highly unusual for metal so thin to survive burial; here, not only did it survive, but in most cases with very little surface corrosion, enabling skilled cleaning to reveal details of manufacture such as tool marks and very faint marking out lines which are a truly remarkable survival. The decoration on the iron bands of the cauldrons was completely unexpected for this class of object, and has opened up new avenues of academic research.

The fragility of the material and the complex issues of recording and presenting the objects also obliged us to trial a wide range of imaging and recording techniques. Everything from micro-tomography, laser scanning and photogrammetry to reflectance transformation imaging and projected light 3D scanning was experimented with to provide an accurate record of the objects throughout their excavation from the soil blocks and their conservation. The majority of these techniques were borrowed from other disciplines and were adapted for use on the cauldrons, many on a small budget using existing equipment and free software as the 3D imaging requirements had not been factored into the funding. The recording of the decoration on the iron bands using reflectance transformation imaging and projected light laser scanning proved particularly successful, as conventional photography was unsatisfactory due to the complex high relief and mottled coloration of the surface corrosion. Images of the handle plates produced using these techniques sit well as an aid to interpretation when viewed alongside the objects. Further processing of the

micro-tomography data (Chapter 5) would also be beneficial to transform the slice data into 3D rendering, making the images more readable and small details more evident.

Public outreach

An important part of the project, and one of the funding requirements set by the Leverhulme Trust, was to communicate the project to the public, museum professionals and students, providing access to the project throughout its duration. The process of conservation of the cauldrons was documented in a short web film on the BM research web page (http://www.britishmuseum.org/research/research_projects/all_current_projects/chiseldon-cauldrons.aspx) and on the BBC web site (<http://www.bbc.co.uk/news/technology-21235980>). The project featured in the BBC's Digging for Britain series, including interviews with Jody Joy and Alexandra Baldwin. The conservation of the cauldrons also formed part of the 'Conservation in Focus' exhibition at the British Museum in October 2008 (**Fig. 106**). During this time the temporary exhibition space became a conservation studio where treatments on the cauldrons were carried out and discussed in front of members of the public (Drago 2011). The Chiseldon project has also featured as a case study as part of the MSc programme in Conservation for Archaeology and Museums at the Institute of Archaeology, University College London for the past five years. Additional lectures have been presented at Cambridge, Cardiff and Leicester Universities and discussions about the cauldrons formed a significant component of the Cambridge University MPhil unit on Museums and Heritage from 2014 to 2016. The project was also awarded 'Rescue Dig of the Year' at the 2009 Current Archaeology Awards.

In addition to this publication, information is recorded on the British Museum's Collections Online database (https://www.britishmuseum.org/research/collection_online/search.aspx), as well as thousands of photographs from the excavation and all stages of conservation which are stored in a digital archive. Additionally, X-rays, drawings and tracings from the micro-excavation and tracings of details of technology and construction of the cauldrons have been scanned and added to the database and are largely accessible via Collections Online as well as through the Museum's internal database. Paper archives of the original drawings and data files too large to place on the database are kept in the Department of Conservation and the Department of Britain, Europe and Prehistory and are available for study upon appointment.

Looking to the future

Five out of the seven blocks lifted from the Chiseldon site and all the fragments associated with the find were conserved. The metal was cleaned to remove adhering soil so that the surface of the metal is visible. Fragments were

joined to preserve associations where known, but owing to limitations of time and resources and the physical condition of the vessels the objects remain in several fragments or sections of reconstructed fragments. As has already been outlined, every attempt was made to leave the objects in a readable state, including packing them in a way that ensures the fragments are oriented correctly and those that join are packed together. The packing was designed so that the objects may be viewed or removed from their boxes without touching the fragile metal; however, full and detailed examination would still require handling the objects and therefore putting them at risk.

Within the two unexcavated blocks from Chiseldon are the three remaining cauldrons including cauldrons 8, 16 and 17 and fragments from cauldrons 5, 6 and 7 including fragments of decorative handle plates. Although every attempt has been made to get as much information about these cauldrons as possible, through cleaning fragments lifted separately during excavation and commissioning CT scanning, without full excavation and conservation, the fine detail of construction including decorative features, patches and rivets remains to be discovered. With additional funding, further research could also be carried out on residues, taking analysis down to isotopic and species determination. Residues were left in situ on the cauldrons where possible for further research. Organic samples remaining on the cauldrons as well as those from other as yet unexcavated blocks could be processed and also be analysed. Metals analysis is another area where further research could be undertaken; however, the condition of the metal may limit the extent of analysis.

The discovery of the 17 Middle Iron Age cauldrons from Chiseldon, rare in itself, has since been supplemented by the discovery of another set of 11 cauldrons from the same period from Glenfield in Leicester in 2009 by Cotswold Archaeology and in 2014 by the University of Leicester Archaeological Services. The conservation and investigation of the Glenfield cauldrons is currently being undertaken by Liz Barham from the Museum of London Archaeology (MOLA). Many of the lessons learned from the investigation of the Chiseldon cauldrons have informed this new project. It has been particularly useful when estimating aspects of time and resources for funding the conservation work, but also what methods and techniques of imaging, conservation and scientific research would be useful and to what level of success they have been applied. Drafts of this publication have also been invaluable in informing the MOLA team of what aspects of technology and manufacture to look for and expect, especially when interpreting CT scans, and also what level of detail and what extent of information can be retrieved from the objects. With the excavation and conservation of the Glenfield cauldrons further studies and comparisons between the two finds will prove highly enlightening.

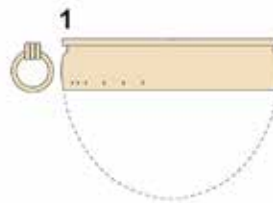
Catalogue of the Cauldrons

Alexandra Baldwin, Jamie Hood and Jody Joy

Note on description and terminology

The cauldrons are described as if they were upright irrespective of orientation in the ground (except for compass orientations). Description is from top down. Measurements are made in millimetres. Band measurements are made on the visible sections on the exterior of the cauldron. Overlaps are noted separately. In descriptions of decoration left side and right side are described looking at the object the right way up. Measurements of handle and rim sections are taken from available cross sections and measured from the cleavage plane between the magnetite and haematite layer, which represents as near as possible the original surface of the object. Rivet distribution is measured from the centre of each rivet. Where the base of the cauldron is incomplete, the depth is estimated from a combination of actual measurements of the depth of the bands and those extrapolated from the curvature of the cauldron and the diameter at the B/C join. For terminology see **Figure 42**.

Cauldrons 1–17



Cauldron 1

Associated SF nos: SF5, SF22, SF23, SF34, SF36, SF37 and SF38.

Images associated with cauldron 1 in this volume: **Figs 16, 17 and 43**.

Position/orientation in the ground: West side of the pit. Cauldron buried on its side under cauldron 4, mouth facing east or southeast with handles top and bottom.

Cauldron type: Globular.

Dimensions: Diameter 448mm. Estimated depth 320mm.

Rim: Hollow rim type 1 with an oval cross section (16 × 18mm).

Band A inserted 9mm into rim. Possible evidence for a rivet through the rim and band A holding the rim in position.

Band A: Width: 83mm. Dogleg in band A below rim. The handle mounts are 32mm wide and tri-ribbed with three ridges on the outer surface. The top central ridge of the handle mount passes through band A below the dogleg and is hammered over a sub-rectangular washer (26 × 39mm) butted up to the rim on the interior. Band A partial and fragmentary – no evidence for any joins remain.

Handles: Diameter 98mm with circular cross section 15mm in diameter.

Band B: Not present (truncated by earlier excavations).

Copper alloy rivets along the A/B join are 5mm in diameter, domed on the exterior and regularly spaced at 39mm.

Bowl C: Not present (truncated by earlier excavations).

Damage: State of the cauldron on deposition unknown as the rim was crushed during burial and a large section of the cauldron truncated during the initial excavation.

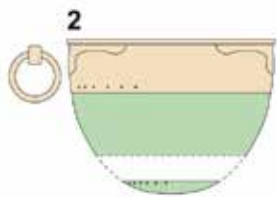
Repairs: None noted.

Tool marks: None noted.

Residues: None noted.

Mineralised organic remains: Mineralised plant material present

on top, exterior and interior of the rim and band A, and in the adjacent soil.



Cauldron 2

Associated SF nos: SF6, SF7, SF30, SF31 and SF32.

Images associated with cauldron 2 in this volume: **Figs 12, 16, 17,**

43, 47, 50, 51, 60, 78a–b, 79a–b and 81.

Position/orientation in the ground: Southwest edge of the pit, upside down with handles oriented in a northeast–southwest direction.

Cauldron type: U-shaped.

Dimensions: Diameter 420mm. Estimated depth 310mm.

Rim: Solid Type 1, sub-rectangular with a cross section 14×11 mm. The outer edge is square while the inner edge is rounded. Two horizontal grooves run around the outer face of the rim.

Band A: Straight convex band 104mm in width inserted 4mm into a groove in the rim. Band A is made in two sections with the riveted overlaps at the handles. Two decorative handle plates in the shape of stylised cattle heads 55–65mm from rim to the bottom of the decorated plate and extending 125–33mm each side of the handle attachment (described in more detail in Chapter 9). Handle mount with a plain band 24mm wide is inserted through band A and the decorative plate just below the rim and riveted onto the interior over a square washer 35×35 mm. Southwest handle and mount missing leaving a small hole in band A.

Handles: Outer diameter 117mm with circular cross section 13mm in diameter. Handles corroded in an upright position.

Band B: Small section remaining (truncated by earlier excavations), original depth of the band >134 mm. Riveted to band A with an overlap of 10–18mm with round copper alloy rivets along the A/B join, which are domed on the exterior (rivet diameter: 3.5mm interior, 5mm exterior). The rivets were punched from the interior to the exterior and regularly spaced at 29mm.

Bowl C: Small area present (truncated by earlier excavations); a fragment of copper alloy from band B indicates the diameter of bowl C was *c.* 200mm. The B/C overlap was 13mm with rivets evenly spaced at 22mm punched from interior to exterior. Rivet heads: internal 4mm domed, external 2mm.

Damage: The southwest handle and mount, adjacent to the pit edge, were missing when the cauldron was deposited in the ground.

Repairs:

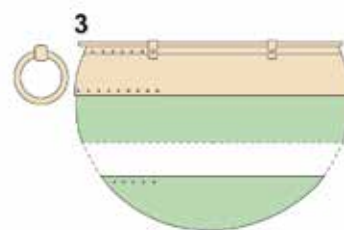
1. Square copper alloy patch 28×30 mm riveted over the A/B join and attached to both A and B at the northeast handle with four copper alloy rivets.
2. Square copper alloy patch 28×30 mm riveted over the A/B join at the southwest handle. Riveted in each corner with copper alloy rivets to both band A and band B over the A/B join.

3. Copper alloy patch over a possible repair to the iron on band A (north side of rim) $>70 \times 30$ mm with iron rivets.
4. Six patches on the south section of band B interior at edge of A/B join. Including shaped patches: quadrilateral, 25×30 mm; elongated octagon, 30×18 mm; truncated ellipse, 25×23 mm.
5. Two small copper alloy patches/rivet washers 12mm square on interior band B along the A/B edge held in place with one copper alloy rivet.
6. Small square copper alloy patch 15×14 mm held by two copper alloy rivets half way down band B.
7. Remains of long rectangular copper alloy patch on bowl C, $>66 \times 29$ mm.
8. The cattle head escutcheon on the southwest handle is repaired on the right ear, with an overlap in the iron sheet and two sets of iron rivets arranged vertically either side of the join. The muzzle also appears damaged – the bottom section is missing and a rivet has been inserted through the tip of the nose.

Tool marks: None noted.

Residues: Sooty deposits on the exterior base of the cauldron. Black residue between band A and the decorative plate. Residue on interior of copper alloy bowl and band A of cauldron.

Mineralised organic remains: Dispersed randomly aligned plant remains on the exterior of band A and under the rim, therefore lining the base of the pit.



Cauldron 3

Associated SF nos: SF8, SF19, SF24, SF25, SF28, SF29, SF35, SF56, SF57, SF59, SF60 and SF61.

Images associated with cauldron 3 in this volume: **Figs 16, 17 and 43.**

Position/orientation in the ground: In the southwest corner of the pit buried upside down, handles oriented east–west. Cattle skull SF55 under rim of Cauldron 3 at base of pit.

Cauldron type: Globular.

Dimensions: Diameter 520mm. Estimated depth 390mm.

Rim: Solid Type 2 sub-rectangular rim (14×7 mm) attached to band A with four clips riveted in place through the A1/A2 overlap.

Band A: Cauldron 3 has two flaring convex iron bands: A1 17mm and A2 85mm wide. The lower edge of A1 is joined to the outside of A2 with an overlap of 12mm. The A1/A2 join is secured with iron rivets regularly spaced at 25 to 26mm. Rivets are 2–3mm in diameter on the interior and 4mm square on the exterior. Four iron trapezoid-shaped reinforcements 35×15 mm on the interior of the A1/A2 join are positioned between the clips. The top rivet passes through the A1 band and the lower rivet through the A2 band. Two joins in band A2 (interior) 66mm either side of the east handle. No corresponding joins on west handle,

although heavy patching in this area may obscure the joins. Plain handle mounts (20mm wide) riveted through band A2 and domed over on the interior over a rectangular washer (east: 28 × 43mm; west: 32 × 34mm).

Handles: 115mm in diameter and circular in cross section (12mm). Handles corroded in an upright position.

Band B: Greater than 100mm in width. A/B overlap of 10–15mm secured with iron rivets punched interior to exterior, measuring 4mm in diameter on the interior and 5mm square on the exterior and spaced at 21 to 26mm apart. No visible join on band B.

Bowl C: Diameter approximately 450mm; depth approximately 130mm. B/C overlap of 8mm secured with copper alloy rivets punched exterior to interior measuring 4mm interior domed and 6mm exterior flat and 22mm apart.

Damage: None noted.

Repairs: Heavily repaired or reinforced on the iron A1/A2 sections especially at the handles:

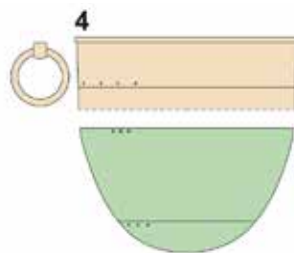
1. Square iron patch >44 × 47mm interior of cauldron east side with lower edge between A2/B join.
2. Square iron patch 30 × 35mm interior of cauldron east side riveted to A2 over A1/A2 join.
3. Rectangular iron patch 17 × 27mm interior of cauldron east side on A2 with one large central rivet.
4. Irregular iron patch 15 × 17mm overlying patch 3 with three iron rivets.
5. Large rectangular iron patch 70 × 40mm on east side of interior of A2.
6. Rectangular iron patch 37 × 18mm adjacent to patch 5.
7. Series of iron patches including 43 × 29mm and 27 × >33mm on the interior of A2 west side.
8. Triangular iron patch 35 × 22mm with three iron rivets on the interior of A2 west side.
9. Rectangular iron patch 75 × 47mm on the interior of A2 west side.
10. Iron patch >120 × >15mm between the A1/A2 join on the exterior east side.
11. Iron patch 20 × 14mm adjacent to patch 10.
12. Iron patch 119 × 18mm over A1 and A1/A2 join exterior east side.
13. Rectangular iron patch 59 × 19mm adjacent to patch 12.
14. Iron patch 140 × 30mm exterior band A2 on right hand side of west handle.

The unusual attachment of the rim may be a replacement or later addition. Minor repairs in the form of overlaps or small patches not visible on the exterior, over stress fractures along the A/B join made at the time of manufacture. Four triangular (maximum dimensions: 80 × 81mm; 60 × 40mm; 60 × 35mm; 50 × 25mm) and one rectangular (50 × 35mm) repairs to the bowl along the B/C join on the west side of the cauldron. There was an additional iron plate (310 × 50mm with a diameter curve of 480mm) riveted along B/C join on the east side of the cauldron, although its purpose remains unclear as there is no fault in the underlying metal and it does not seem to be a repair.

Tool marks: None noted.

Residues: Black sooty deposit on the exterior bowl of the cauldron. Possible food residues on the interior and between the B/C join on the northeast side of the cauldron.

Mineralised organic remains: Randomly aligned plant material on the exterior of band A on all sides of the cauldron and the top of the rim probably from the possible lining of the floor of the pit.



Cauldron 4

Associated SF nos: SF1, SF2, SF3, SF9, SF16, SF17, SF20, SF33, SF58, SF62, SF66, SF67 and SF71.

Images associated with cauldron 4 in this volume: **Figs 16, 28a–c, 43, 48, 63 and 71a–b.**

Position/orientation in the ground: Positioned in the pit just west of centre, upside down with the handles oriented in north–northeast–south–southwest position. Truncated during original excavation.

Cauldron type: U-shaped.

Dimensions: Diameter 450mm. Estimated depth 450mm.

Rim: Solid type 1 rim sub-rectangular in cross section (16 × 11mm). Band A inserted into a groove in the underside of the rim in an off-centre position.

Band A: Straight convex. Cauldron 4 has two iron bands: A1 and A2. A1 width 87mm and riveted to the outside of A2. A2 width >51mm (incomplete, truncated by initial excavation). A1/A2 overlap 11mm with iron rivets spaced between 31 and 36mm apart. Rivet heads domed 4.5mm in diameter on the exterior, and flat 3–4mm in diameter on the interior. Band A1 was made in two sections; vertical overlaps of 20mm are visible 98mm to the west of the southwest handle at a slightly off-vertical angle, and 45mm to the east of the northeast handle. Not enough of band A2 survives to determine position or number of joins. Plain handle mounts 19mm wide passing through band A1 10mm below the rim, and riveted on the interior over a rectangular plate butted against the rim. Northeast handle plate 23 × 37mm, southwest handle plate 28 × 35mm. The northeast handle mount is riveted through the washer in an off-centre position.

Handles: 121mm in diameter with a circular cross section of 14mm. The orientation of the handles during burial (south–southwest handle diagonal and north–northeast handle vertically upwards) indicates the handles were able to rotate as well as pivot.

Band B: Width of 212mm. A/B overlap 13mm. The rivet holes on band B along the A/B join have been punched from the interior to the exterior and secured with flat-headed copper alloy rivets 8mm in diameter on the interior (exterior rivet heads obscured) and evenly spaced at 14–15mm apart. No evidence for join in band B.

Bowl C: Diameter approximately 330mm. Depth 110–20mm. B/C overlap 10mm secured with rivets 2–3mm in diameter, square on the interior and round on the exterior and spaced 16–18mm apart, except where they cluster around fatigue cracks at the edge of the bowl.

Damage: Two-thirds of cauldron survives, but difficult to determine condition on deposition owing to metal detector disturbance.

Repairs:

1. Iron strip 38mm wide wrapped up and over the rim and onto the A1 band next to the southwest handle extending 35mm on exterior and 30mm onto interior.
2. Copper alloy rivet and square washer repair to fatigue crack on the exterior of B at A/B join.
3. Copper alloy rivet and washer repair to fatigue crack on the exterior of C at B/C join. 3mm square-headed rivet punched interior to exterior.
4. Copper alloy oval patch and sub-hexagonal patches to fatigue cracks on interior of C at B/C join. 3mm square rivets punched interior to exterior.

Copper alloy heavily repaired with multiphase patching of different shapes and sizes with different rivet heads (all punched interior to exterior) on the interior of band B:

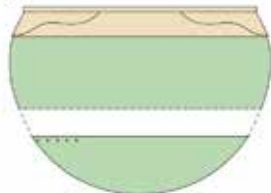
1. Eight overlapping copper alloy patches along A/B join; mixture of shaped and sized patches haphazardly aligned. Rivet sizes vary.
2. Five overlapping copper alloy patches half way up band B. Mixture of rectangular and roughly cut scrap sheet. Lower patches neater with small rivets 2–4mm in diameter. Upper patches rivets 5mm in diameter.
3. Rectangular copper alloy patch 16 × 46mm butted against the B/C overlap on the exterior of band B.
4. Paperclip repair visible on interior covered on exterior by patch 7.
5. Rectangular copper alloy patch >38 × 20mm interior of B at B/C join south side (detached fragment).
6. Rectangular copper alloy patch approx. 40 × 45mm interior of B at B/C join south side (detached fragment).

Tool marks: Perpendicular linear tool marks on the interior surface of band B running diagonally to band. Edge of bowl C cut then hammered.

Residues: Sooty deposits on the exterior copper alloy base of the cauldron. Residue samples taken from between riveted joins of copper alloy interior and base.

Mineralised organic remains: Mineralised organic remains of randomly aligned plant materials from the fill of the pit and possible pit lining covering the exterior of the iron rim and band A. Area of possible skin product or hide and hair on exterior of rim and band A at south; preservation poor.

5



Cauldron 5

Associated SF nos: SF10, SF21, SF26, SF27, SF69, SF72, SF76, SF77, SF80, SF83, SF85, SF89, SF90, SF94, SF96 and SF99.

Images associated with cauldron 5 in this volume: **Figs 16, 17, 39, 40, 43, 73 and 82a–b.**

Position/orientation in the ground: North of the pit centre under the northeast side of cauldron 4 and over the northern edge

of cauldron 6. The cauldron was buried upside down with handles in a northwest–southeast orientation.

Approximately two-thirds of band A, band B and bowl C truncated by earlier excavations.

Cauldron type: Globular.

Dimensions: Diameter 480mm. Estimated depth 380mm.

Rim: Solid type 1 sub-rectangular rim 17 × 11mm. Band A inserted 7mm into a groove in the underside of the rim in an off-centre position.

Band A: Flaring convex band 55mm in depth. Joins between sections of band A are not visible. Decorative handle plates on the exterior of band A extend 160mm each side of the handle and 50mm from below rim to edge of A at A/B join. Handle attachment inserted through band A and the decorative plate and butted against the underside of the rim. Remains of an oval handle washer 35 × 66mm secured to band A with five rivets around the curve each side. Washer rivets appear to go through to the exterior of decorative plate.

Handles: North handle missing – removed prior to burial. South handle unexcavated in block 10/11.

Band B: Exact width unknown >148mm. Band B riveted to the interior of A with an A/B overlap of 11mm. The rivet holes on band B along the A/B join have been punched from the interior to the exterior and secured with square domed iron rivets 5mm in diameter on the interior (exterior rivet heads obscured) and evenly spaced at 38mm apart. No evidence for join in band B.

Bowl C: Diameter approximately 440mm. Depth unknown. Bowl C riveted to the exterior of B with a B/C join overlap of 11mm secured with flush circular rivets heads 3–4mm in diameter, punched from the interior to the exterior and spaced at 17–24mm. Fragment of band B from B/C join found adjacent to the northern rim section has rivets with spacing 6–10mm apart. Possible repair riveting interspersed with the original rivets.

Damage: North handle of cauldron missing – detached prior to burial, handle plate still present, but removal caused damage to the decorative plate and band A. Large sections approximately a half to two-thirds of band A, band B and bowl C adjacent to cauldron 4 were truncated by metal detectorist and therefore it is impossible to tell how complete base of cauldron was on deposition.

Repairs: Evidence of patching or overlaps in the iron of band A near the A/B join on un-located fragments. Three fancy patches covering fatigue cracks at the upper edge of band B along the A/B join:

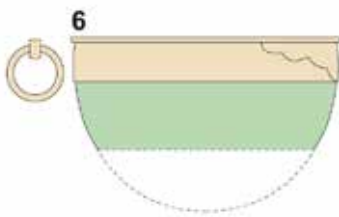
1. Tapering copper alloy scalloped-edged patch 25 × >30mm on detached fragment. Covering stress fracture on top edge of B adjacent to A/B join. Copper alloy rivets internal 3mm square, external 3mm round. Riveted interior to exterior. Scallops 6mm in length.
2. Triangular copper alloy scalloped-edged patch 35 × 30mm riveted to detached fragment of band B adjacent to A/B join from northwest rim area. Six copper alloy rivets three of which have triangular, circular or square rivet washers both front and back. Scallops 6mm in length alternating with scallops 2mm in length at tapered end. Stress fracture on the exterior trimmed into a u-shape.

3. Tapering copper alloy scalloped-edged patch on the east side of band B at A/B join measuring $>44 \times 30$ mm. Scallop 5–7mm with 3mm flush-headed copper alloy rivets passing through alternate scallops. One of the rivets is reinforced on the interior of the cauldron with a small trapezoid copper alloy washer 4×5 mm. Stress fracture on the exterior trimmed into a u-shape.
4. Sub-square copper alloy patch 35×22 mm on the interior of band B held with four copper alloy rivets 3mm domed on the interior.
5. Flattened oval copper alloy patch 21×14 mm on fragment of band B adjacent to west rim held in place by two copper alloy rivets.
6. Series of four overlapping rectangular copper alloy patches on fragment of band B near the A/B join (14×5 mm; 20×8 mm; 23×7 mm; 31×14 mm) placed with longest edge parallel to A/B join. Lower edge of largest patch wavy. Copper alloy rivet heads of three lower patches circular 4mm in diameter and flush, uppermost patch rivet heads 2mm square domed on interior.
7. Small sub-rectangular copper alloy patch 10×19 mm held in place by two copper alloy rivets with 3mm diameter heads riveted to the interior of the north side of cauldron adjacent to the A/B join.

Tool marks: Faint linear striations across the interior surface of the copper alloy and at the lower edge of B near B/C join running diagonally top left to bottom right. The edges of the copper alloy sections are bevelled with distinct over-cuts on the lower edge of B and the edge of C at the B/C join indicating the use of shears or snips.

Residues: Sooty deposits present on the exterior base of the cauldron. Black food residue 2–3mm thick on the interior of A and B and on the exterior of A filling the decoration. Thick residue under the lip of the rim, and between the metal sections at the A/B and B/C join. Sampled: Interior east side from copper alloy band B; surface of scalloped patch along A/B join; between B/C join exterior of cauldron; bottom of band A interior of cauldron.

Mineralised organic remains: Very few mineralised organic remains preserved on the rim and band A of the cauldron.



Cauldron 6

Associated SF nos: SF11, SF40, SF63, SF65, SF81, SF84 and SF96.

Images associated with cauldron 6 in this volume: **Figs 16, 17, 26, 39, 40, 43, 52 and 84a–b.**

Position/orientation in the ground: In the centre of the pit adjacent to and underlying cauldrons 5 and 4. Eastern edge of cauldron 6 overlaps mouth of cauldron 9. Cauldron buried upside down. Handles oriented east–west.

Cauldron type: U-shaped.

Dimensions: Diameter 540mm. Estimated depth 360mm.

Rim: Solid type 1 rim sub-rectangular in cross section 12×9 mm. Band A inserted 5mm into a groove in the underside of the rim in an off-centre position.

Band A: Straight convex band 80mm in depth. No joins visible on band A. Two decorative handle plates positioned below rim. Decorative plate 79mm wide from rim to bottom of plate and 150mm each side of the handle mounts (described in more detail in Chapter 6). Plain handle mounts 27mm wide inserted through band A and the decorative plate and butted against the underside of the rim. The handle mount domed over a sub-square washer measuring 40×40 mm at the west handle and oval or sub-rectangular 34×30 mm at the east handle.

Handles: 110mm in diameter with a circular cross section of 17mm. The orientation of the handles during burial (west handle in the down position but twisted by 90 degrees, east handle down) indicates the handles were able to rotate as well as pivot.

Band B: Greater than 140mm. Band B riveted to the interior of A with an A/B overlap of 12–14mm. The copper alloy rivets along the A/B join are evenly spaced at 29–32mm. Rivet heads 4mm square on the interior and 4mm round exterior, punched from the interior to the exterior.

Bowl C: Unexcavated in block.

Damage: None noted.

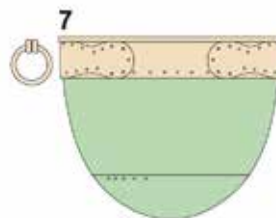
Repairs:

1. Circular iron patch 35mm in diameter on the interior of band A below west handle washer riveted with one central iron rivet (9mm interior, 5mm exterior). Riveted through band A but not decorative plate.
2. Tongue-shaped iron patch 17×27 mm on interior of band A held in place with two iron rivets 4mm internal.
3. Tapering copper alloy scalloped-edged patch 50×22 mm covering fatigue crack on band B at A/B join. Scallop 5mm long held by six copper alloy rivets 4mm internal and external. Rivet holes punched from the interior to exterior.

Tool marks: None noted.

Residues: Black deposit approximately 1mm thick on top of the decoration and under the lip of the rim – possible food residues.

Mineralised organic remains: Mineralised plant material on the exterior of rim and band A east side.



Cauldron 7

Associated SF nos: SF13, SF41, SF42, SF43, SF44, SF46, SF47, SF50, SF53, SF74, SF75, SF78, SF79, SF88, SF92, SF93 and SF95.

Images associated with cauldron 7 in this volume: **Figs 16, 17, 43, 47 and 85a–b.**

Position/orientation in the ground: At the northern edge of the pit above cauldron complex 12 and 13 and rim overlapping

cauldron 8. Fragment 18 directly overlies cauldron 7. Cauldron 5 overlies the 18/7 complex on its southern edge. Cauldron 7 was placed in the ground the right way up with handles oriented in an east–west position.

Cauldron type: U-shaped.

Dimensions: Diameter 450mm. Estimated depth 370mm.

Rim: Hollow type 2 rim consisting of a flat strip of iron which has been curved over the upper edge of band A with its edges rolled inwards 13 × 10mm.

Band A: Straight convex band 76mm in depth and extending into the rim by 5mm. Band A possibly made in four sections. The west handle is mounted on sections of iron sheet with curved ends which extend 190mm and 150mm either side of the handle mount. Detached fragments indicate similar at east handle. Decorative domed iron rivet heads (5mm diameter) join these sections to the intermediary bands. The handle mounts are formed of a possibly bi-lobed band 14mm wide inserted through and secured on the interior of band A and domed over a double washer butted against the rim and semi-oval in shape measuring 30 × 90mm and 20 × 40mm.

Handles: 96mm in diameter with a circular cross section of 14mm.

Band B: Width 225mm. A/B overlap 14mm. The rivet holes on band B along the A/B join are 2mm in diameter and have been punched from the interior to the exterior and secured with copper alloy rivets 4mm on the interior and 5mm domed rivet heads on the exterior. They are evenly spaced at 31mm apart. Top of band B wavy from hammering after cutting to shape/untrimmed. No evidence for a vertical join in band B.

Bowl C: Not present, detached along the B/C join prior to deposition. Curve of B/C join indicates the diameter of the bowl was approximately 350mm. B/C join: overlap 11mm secured with flat-headed rivets (4–5mm internal, 3mm external diameter) punched from the interior to the exterior and regularly spaced at 21mm apart. Secondary riveting 2mm punched interior to exterior along the north section of B/C join – possible repair.

Damage: Bowl detached prior to deposition in the ground below B/C join. East handle missing.

Repairs: Evidence from detached fragments of band A including SF46, 74, 79, 88 and 92 indicate patching to the iron of band A with iron patches both internally and externally. Numerous multiphase patches on the interior of the copper alloy along A/B and B/C join characterised by the use of rivet washers on the interior and exterior:

1. Decorative cloud-shaped scalloped copper alloy patch 28 × 9mm located on the interior of the cauldron on the south side of band B at the base of an overlapping fatigue crack. Five round copper alloy rivets hammered flush (3mm).
2. Oval copper alloy patch 26 × 15mm on south side of cauldron across fatigue crack overlap on band B at A/B join. Two circular copper alloy 4mm rivets. Riveted interior to exterior.
3. Tongue-shaped copper alloy patch 25 × 16mm; half way up band B on south side of cauldron; three copper alloy rivets 3mm rivet heads, domed on the exterior.
4. Oval copper alloy patch 23 × 16mm; north side band B near A/B rim; 3mm circular copper alloy rivets heads.

5. Tongue-shaped copper alloy patch 47 × 21mm. Northeast side of band B underlying rectangular copper alloy patch 23 × 26mm. Exterior square and circular copper alloy rivet washers associated with tongue-shaped patch. Circular flush copper alloy rivet heads 4mm interior, 3mm exterior.
6. Triangular iron tab 18 × 40mm; across A/B join on the interior of the cauldron on the northwest side. Secured with two iron rivets 5mm.

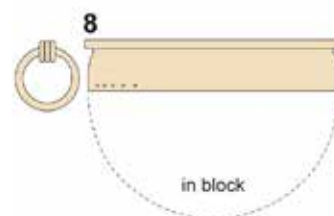
On band B along B/C join: south and east side – large patches to the interior of the cauldron:

1. Wavy-edged copper alloy patch 123 × 20mm; round copper alloy 5mm rivets punched interior to exterior, domed on the exterior.
2. Rectangular copper alloy patch 62 × >110mm; round copper alloy rivets 3–4mm interior, 2–3mm exterior, punched interior to exterior.
3. Corner of large copper alloy patch >55 × >32mm; 4mm flush, round copper alloy rivets.
4. Corner of large copper alloy patch >83 × >38mm. 4mm flush, round copper alloy rivets.
5. Edge of large copper alloy patch >80 × 35mm possibly associated with patch 10; 4mm flush, round copper alloy rivets.
6. Six irregularly shaped overlapping multiphase copper alloy patches on the west side of B along B/C join; uppermost patch 55 × 30mm with round copper alloy rivets 4–5mm diameter. Lower patches: 3mm square copper alloy rivet heads; associated with the use of eight square and triangular copper alloy rivet washers on the interior and exterior.
7. Remains of triangular copper alloy patch with wavy edge 25 × >15mm; on northern section of B across B/C join; copper alloy rivet heads 2–3mm in diameter; two copper alloy rivet washers with cut edges on the interior above the patch.
8. Small rectangular copper alloy patch 20 × 12mm adjacent to the B/C join; two copper alloy rivets 2–3mm in diameter.
9. Cluster of square and triangular copper alloy rivet washers on the interior of band B close to the B/C join.

Tool marks: Possible over-cut marks on the B/C edge of B.

Residues: Sooty deposits on the lower exterior of band B.

Mineralised organic remains: None noted (owing to position between 4 and 149/150).



Cauldron 8

Associated SF nos: SF82, SF97, SF114 and SF118.

Images associated with cauldron 8 in this volume: **Figs 16, 17, 38, 43, 54, 64 and 77.**

Position/orientation in the ground: Located at the northeastern edge of the pit positioned the right way up with mouth at a

slight angle into the centre of the pit. Western edge of rim overlaid by cauldron 5. Handles oriented north–south.

Cauldron type: Globular.

Dimensions: Diameter 520mm. Estimated depth 350mm.

Rim: Hollow rim type 1 with almost triangular cross section of 20mm × 17mm.

Band A: 66mm wide with a dogleg below the rim. Band A extends 7mm into the rim. The handle mounts are 34mm wide and 30mm in diameter with three ridges on the outer surface and mounted on band A below the dogleg. The top central ridge of the handle mount passes through band A and is hammered over an oval washer 40 × 53mm butted up to the rim on the interior.

Handles: 130mm in diameter with a circular cross section of 15mm. The orientation of the handle during burial upright and at slight angle, but width of handle attachment and proximity to rim does not allow much room for pivot if any.

Band B: Width unknown. A/B overlap 11mm. The rivets along the A/B join are 7mm internal 5mm external domed copper alloy rivets. They are evenly spaced at 25mm apart.

Bowl C: Unexcavated in block.

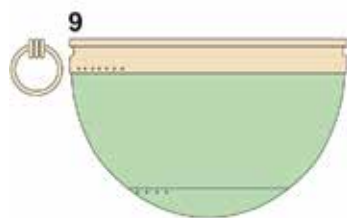
Damage: Unknown.

Repairs: Unknown.

Tool marks: Linear diagonal tool marks on band B visible in X-ray.

Residues: None noted.

Mineralised organic remains: Preserved on the interior of the rim and band A – small twigs and grass-like material possibly packing/pit lining/covering. Exterior of rim and band A on southwest section from pit lining and fill.



Cauldron 9

Associated SF nos: SF86, SF87, SF98, SF102, SF106, SF112, SF113, SF115, SF119, SF121, SF122, SF157, SF158, SF153 and SF154.

Images associated with cauldron 9 in this volume: **Figs 13, 14, 16, 17, 18, 22, 24, 25, 43 and 46.**

Position/orientation in the ground: Located at the eastern edge of the pit and positioned at a slight angle with the mouth of the cauldron facing into the pit. Handles are oriented northeast–southwest. Cauldrons 14 and 15 were positioned inside vessel 9 with cauldron 6 overlapping the lower western rim of the cauldron.

Cauldron type: Globular.

Dimensions: Diameter 560mm. Depth 360mm.

Rim: Hollow rim type 1. A hollow tube wrapped over the rim with a flatter profile on the interior than the exterior. 15 × 18mm. Band A inserted 12mm into the rim. Remains of wood in the rim cross section between the band and outer curve of the rim appears to be a half-round section (**Fig. 46**).

Band A: Width 54mm. Dogleg in band A below the rim. The handle mounts are 30mm wide and tri-ribbed with three

ridges on the outer surface. The top central ridge of the handle mount passes through band A just below the rim and is hammered over a washer butted up to the rim on the interior. The east handle washer is 25 × 30mm, the west handle washer 27 × 30mm both rectangular. Possible overlapping join on interior of band A 33mm to the left-hand side of the east handle, not visible on the exterior owing to mineralised organic remains. No join visible on west handle owing to fragmentary condition.

Handles: 106mm in diameter with a circular cross section of 12mm. The orientation of the handles during burial indicates the handles were able to rotate as well as pivot with both handles rotated to the side by 45–90 degrees.

Band B: Width 232mm with an A/B overlap of 12mm.

Circular copper alloy rivet heads along the A/B join 7mm in diameter, flush on the interior and domed on the exterior, punched from the interior to the exterior. Evenly spaced at 14mm. Edge of B at A/B join straight and cut. No evidence for a vertical join in band B.

Bowl C: Diameter 320mm. Depth approximately 80mm.

Overlap at B/C join 20mm secured with flat-headed rivets, internal 5mm square, external 3–5mm round, punched from the interior to the exterior and regularly spaced at 18mm.

Damage: Cauldron appears to have been complete at the time of deposition.

Repairs: No repairs visible on band A. 13 patch repairs to the copper alloy of band B (described below); all appear to be repair to damage rather than stress fractures. No repairs to C.

1. Sub-triangular copper alloy patch 35 × 30mm on the B/C join; five 3–4mm copper alloy rivets square-headed on the interior; rivets at the corners and middle of the patch.

Numerous patches on the interior of band B at western side of the cauldron where the copper alloy is extremely thin.

1. Truncated oval copper alloy patch 25 × 19mm; two 4mm internal square-headed copper alloy rivets.
2. Curved rectangular copper alloy patch 20 × 9mm; two 3mm copper alloy rivets square-headed on interior.
3. Truncated ellipse-shaped copper alloy patch 15 × 10mm; two 3mm internal square-headed copper alloy rivets. Adjacent to patch 3.
4. Large rectangular copper alloy patch 110 × 44mm running down width of band B; 3mm square-headed copper alloy rivets on interior.
5. Irregular rectangular copper alloy patch 38 × 29mm; four copper alloy rivets 4mm square-headed on interior, 3mm round exterior.

Patches along south and eastern interior of cauldron:

1. Irregular rectangular copper alloy patch 30 × 18mm with three square-headed copper alloy rivets.
2. Rectangular copper alloy patch 20 × 16mm near the A/B join with four round-headed copper alloy rivets.
3. Curved rectangular copper alloy patch 25 × >10mm.
4. Rectangular copper alloy patch 28 × 16mm with four round copper alloy rivets.
5. Rectangular copper alloy patch 54 × 17mm attached with eight square copper alloy rivets distributed four evenly down each long side.
6. Sub-rectangular copper alloy patch 22 × 17mm with two rivets, one round, one square.

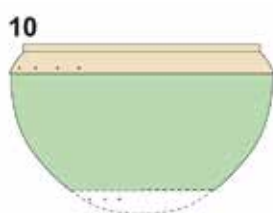
Two patches attached to an un-relocated fragment of copper alloy from northeast area of cauldron:

1. Rectangular copper alloy patch 30 × 23mm secured by four copper alloy rivets.
2. Comma-shaped copper alloy fancy patch with scalloped edges 15 × >30mm; scallops – smallest 2mm in width; one copper alloy rivet 5mm; rivets reinforced with 11mm square copper alloy washers on the exterior.

Tool marks: Possible over-cut marks on the B/C edge of band B and marking out lines on interior. Tool marks on B.

Residues: Sooty deposits on the lower exterior of the cauldron. Residue samples taken from the interior of the copper alloy of band B and bowl section C and from between the B/C join on the south side of the cauldron.

Mineralised organic remains: Extensive mineralised remains over the east handle (at the pit edge) and exterior of rim and band A as well as in the fill of cauldron g indicating both pit lining and covering.



Cauldron 10

Associated SF nos: SF105, SF108, SF109, SF110, SF120, SF126, SF127, SF130, SF132 and SF135.

Images associated with cauldron 10 in this volume: **Figs 16, 17, 32, 43, 56a–b, 62 and 65.**

Position/orientation in the ground: In the southeast corner of the pit mouth angled downwards over adjacent cauldron 11. Handles not present, but handle plates indicate an east–west orientation.

Cauldron type: Globular.

Dimensions: Diameter at rim 484mm. Estimated depth 340mm.

Rim: Solid type 1 sub-rectangular rim 19 × 13mm with sharp outer and rounded inner angles, band A inserted 7mm into a groove in the rim.

Band A: Width 55mm. Flared convex band – flares out from just below the rim at a sharp angle. Diameter of the cauldron at the bottom of band A on A/B join is 534mm. Handle attachment passes through band A below the rim and is hammered over a rivet washer on the interior. West handle washer: semi-circular 41 × 54mm with the flat edge butted up to the rim and riveted to band A by three rivets 6mm internal, 3mm external. Riveted over earlier round handle washer. A hole through to the exterior 8mm diameter indicates the position of the handle attachment 16mm below rim. East handle washer: oval 40 × >61mm riveted to band A with internal 3mm rivets, external obscured. Hole to exterior 12mm in diameter indicated the position of the handle attachment 34mm below rim.

Possible join in band A 31mm to the left-hand side of the west attachment (not present on the east side as band A fragmentary).

Handles: Not present at deposition.

Band B: Width 210–35mm with an A/B overlap of 9mm.

Copper alloy rivets along the A/B join, 5mm domed on the exterior, 4mm round on the interior, positioned regularly at 40–4mm intervals. No evidence for a vertical join in band B.

Bowl C: Not present – removed from cauldron prior to deposition. Curve at the bottom of band B indicates a probable diameter of 270–80mm with a B/C overlap of 15–20mm. Rivets along the B/C join, 3mm square on the interior, 4mm and round on the exterior, positioned regularly at 26–30mm intervals.

Damage: Cauldron deposited without handles, handle attachments or bowl section C.

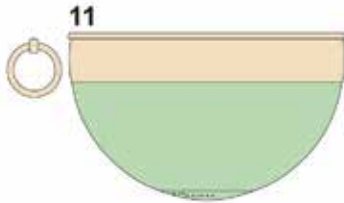
Repairs: Scalloped-edged patches over fatigue cracks along the top of band B at the A/B join:

1. Rectangular scalloped copper alloy patch 22 × 16mm with straight edge along A/B join. Over fatigue crack on southeast side of cauldron. Scallops 3–5mm held in place by five copper alloy rivets.
2. Rectangular scalloped copper alloy patch 32 × 29mm with straight edge along A/B join. Over fatigue crack. Scallops 6–9mm held in place by six copper alloy rivets.
3. Rectangular scalloped copper alloy patch 14 × 14mm with straight edge along the A/B join. Over fatigue crack. Scallops 3–7mm held in place with two copper alloy rivets.
4. Square scalloped copper alloy patch 47 × 47mm with three scalloped edges, straight edge along the A/B join covering fatigue crack which has been cut out on exterior. Scallops 6–10mm. Iron rivet washers, both 12 × 11mm, front and back over one corner of the patch at the A/B join.
5. Trapezoidal copper alloy patch 44 × 53mm covering bottom of scalloped patch 4 held in place with four square-headed copper alloy rivets.
6. Rectangular copper alloy patch 21 × 14mm with curved corners. Attached to band B with two copper alloy rivets.
7. Large rectangular iron patch >227 × 29mm; on interior northeast side of cauldron, riveted to band A and B across the A/B join. Held in place with square, domed, iron rivets visible on exterior of band B. Rivets spaced 21–9mm apart.
8. Oval copper alloy patch 17 × 12mm. Attached to south side of band B with circular copper alloy rivets.

Tool marks: Possible over-cut mark at edge of B at B/C join, also bevelled edge indicating the edge was cut with shears/snips.

Residues: Sooty deposits on the exterior of band B. Black concretions approximately 1mm thick on the interior of both band A and band B.

Mineralised organic remains: Randomly aligned plant material present on the east side of the cauldron rim and band A (edge of pit) and on top of the rim (top of cauldron).



Cauldron 11

Associated SF nos: SF101, SF123, SF124, SF126, SF127, SF128 and SF129.

Images associated with cauldron 11 in this volume: **Figs 16, 17, 23, 43, 47, 57a–b and 67.**

Position/orientation in the ground: East side of the pit in the mouth of cauldron 10. Vessel on side with mouth facing the east. Handles oriented east (bottom of pit)–west (top of pit).

Cauldron type: U-shaped.

Dimensions: Diameter 550mm. Depth 340mm.

Rim: Solid type 1 rim with sub-square cross section 13 × 12mm. Band A inserted 10mm into a groove in the underside of the rim.

Band A: Width 92mm. Straight convex band. Plain handle mounts 22mm wide riveted through band A and secured on the interior over a rectangular washer (25 × 40mm east; 37 × 25mm west) which butts up under the rim. Evidence for joins in band A on east side of cauldron, 90 and 110mm each side of east handle on interior. Visible both on the interior and exterior with 15–20mm overlap riveted with flush iron rivets. No joins visible at west handle.

Handles: Diameter 110mm, round cross section 12mm in diameter.

Band B: Width 224mm. Attached to band A with copper alloy rivets, exterior 2–3mm domed square, interior 3mm flush round. Distance between rivets is regular 21–4mm. A/B overlap is 12–15mm. No evidence for join in band B.

Bowl C: Diameter 170mm. Depth approximately 30mm. B/C overlap is 7–10mm. Rivets 3mm in diameter, both square and round on the interior and round and flush on the exterior. Distance between rivets regular 12mm.

Damage: Probably whole when buried.

Repairs: There are five decorative patches covering fatigue cracks in the metal at the edge of B along the A/B join:

1. Copper alloy fancy patch resembling a claw 54 × 25mm. Over fatigue crack on B at A/B join. Five copper alloy sub-square rivets, diameter external 6mm, internal 5mm.
2. Copper alloy fancy patch resembling a fishtail 52 × 25mm. Over fatigue crack on B at A/B join. Four copper alloy rivets. Rivet head diameter external 5mm, internal 4mm.
3. Remains of scalloped copper alloy fancy patch >55 × 24mm running vertically down band B. Three copper alloy rivets remaining. Rivet head diameter external 5mm, internal 4mm.
4. Copper alloy fancy patch 24 × 38mm on band B at A/B join partially obscured by corrosion. Copper alloy rivet head diameter 4mm interior.
5. Small scalloped copper alloy patch 22 × 8mm. Positioned vertically half way down band B. Two copper alloy rivets.
6. Square copper alloy patch 14 × 15mm. On B near B/C

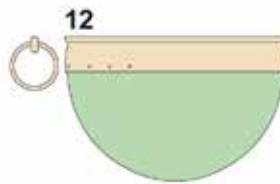
join. Four round copper alloy rivets, interior 4mm, exterior 2mm.

7. Further evidence of copper alloy patches from rivets and remaining patch fragments near B/C join.
8. Copper alloy rivet with square copper alloy washer 10 × 9mm. Copper alloy rivet heads interior round 3mm, exterior round 2mm.
9. Copper alloy paperclip repair 12 × 8mm interior; exterior two flaps 6 × 3mm and 6 × 7mm.
10. Large copper alloy truncated oval patch on interior of cauldron on C, 150 × 80mm, with long axis over the B/C join. Copper alloy rivets exterior 2mm round, interior 3mm round. Punched interior to exterior. The patch is riveted to the interior over the B/C join, but follows a step in the lower edge of B.

Tool marks: Marking out lines visible on copper alloy band B along A/B join. Planishing marks and linear tool marks from shaping on band B.

Residues: Black powdery carbon residues on the outer base of the cauldron. Residues sampled: hard encrusted black residue in interior of the copper alloy band B and bowl section C.

Mineralised organic remains: thick layer (5mm thick) of organic remains covering the exterior of the west (uppermost) rim and handle and the interior of the east (bottom) rim, less on east exterior rim. Organic material appears to be small stem grass-like material probably from pit lining/covering.



Cauldron 12

Associated SF nos: SF149.

Images associated with cauldron 12 in this volume: **Figs 16, 17 and 43.**

Position/orientation in the ground: Cauldron found at the northern edge of the pit in an upright position nestled inside cauldron 13. The 12/13 cauldron group was under cauldron 7 and fragment 18. Handles oriented northeast–southwest. Handles hanging down as cauldrons deposited upright in the pit.

Cauldron type: Globular.

Dimensions: Diameter 450mm. Estimated depth 290mm.

Rim: Solid type 1 rim with a sub-rectangular cross section with curved interior and angled exterior rim edge measuring 14mm × 10mm. Band A inserted 6mm into a groove in the underside of the rim.

Band A: Width 64mm. Straight convex band measuring 450mm in diameter at both the rim and A/C join. The northeast handle mount is 14mm in width and plain. The top of the handle mount passes through band A below the rim and is hammered over a washer on the interior (obscured). Southwest handle, mount and washer not present. Possible overlapping join in band A 30mm to the left-hand side of southwest handle (obscured on the northeast handle).

Handles: 99mm in diameter with a circular cross section of 10mm. The orientation of the handles during burial vertical but handle attachment twisted slightly indicating the handles were able to pivot as well as rotate. Southwest handle, mount and back plate not present.

Bowl C: Copper alloy section of the cauldron made of a single bowl without central band B. Bowl C joined directly to the interior of band A with both copper alloy and iron rivets present on the interior of the copper alloy at the A/C join. The iron rivets are only visible on the interior of C and are spaced at 40–5mm intervals and are 5mm in diameter and hammered flush. The copper alloy rivets are spaced regularly at 26mm and are 3mm in diameter on the interior and 4mm and domed on the exterior. The diameter of the bowl at the A/C join is 450mm, and the bowl depth is 226mm, approximately half the diameter, therefore the bowl is hemispherical.

Damage: The base of the cauldron appears to have been damaged before deposition with approximately one-third of the copper alloy missing. Edges appear to be irregular and probably torn rather than cut. Southwest handle, mount and washer not present at deposition.

Repairs:

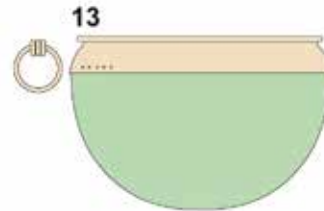
1. Large copper alloy v-shaped scalloped patch 190 × 65mm with five copper alloy rivets positioned at regular intervals down each side and one at the apex. Rivet diameter 3–4mm internal and external. Over stress fracture along the A/C join, edge of split cut to neaten appearance from the exterior.
2. Small copper alloy v-shaped scalloped patch 20 × 26mm. Adjacent to patch 1 over stress fracture along A/C join. Three copper alloy rivets, one at each angle. Rivet head diameter 3mm internal and external.
3. Square copper alloy patch 20 × 23mm covering the top right corner of patch 2. Three copper alloy rivets. Rivet head diameter internal 3mm flush, external 4mm raised.
4. Round iron rivet washer 13mm diameter on the interior of the bowl along A/C join. Iron rivet 4mm diameter internal, external not visible.
5. Small copper alloy triangular patch 37 × 18mm held in place with two iron rivets along the A/C join. Rivet heads 5mm in diameter on the interior.
6. Small rectangular copper alloy patch/rivet washer 13 × 9mm held in place by one iron rivet, 3mm domed internal and external diameter.
7. Oval copper alloy patch 12 × >14mm. Two copper alloy rivets, internal and external rivet head diameter 3mm. Internal rivets domed.
8. Triangular copper alloy patch 20 × 24mm. 26mm below A/C join. Three copper alloy rivets, internal 4mm, external 2mm square heads, positioned over the bottom corner of patch 9.
9. Rectangular scalloped copper alloy patch 30 × 35mm. Four copper alloy rivets, internal 4mm, external 2mm square-headed rivets.
10. Triangular v-shaped scalloped copper alloy patch 28 × 20mm. Three round-headed copper alloy rivets, 3mm internal and external rivet diameter.
11. Small v-shaped copper alloy scalloped patch 22 ×

12mm. Detached from the cauldron. Three copper alloy rivets. Rivet head diameter internal 2mm, external 3mm. Riveted interior to exterior.

Tool marks: Faint marking out lines present on the copper alloy of bowl C at A/C join marking the overlap.

Residues: Sooty deposits and blackening of the copper alloy on the external base from hanging over a fire. Residue sampled from the interior of cauldron rim and band A and between copper alloy of band B and scalloped patch.

Mineralised organic remains: Few noted due to the position in the pit.



Cauldron 13

Associated SF nos: SF150.

Images associated with cauldron 13 in this volume: **Figs 16, 17, 43, 47 and 49.**

Position/orientation in the ground: Found at the northern edge of the pit in an upright position resting on the base of the pit with cauldron 12 nestled inside. The 12/13 cauldron group was under cauldron 7 and fragment 18. Handles oriented north–south.

Cauldron type: Globular.

Dimensions: Diameter 500mm. Estimated depth 350mm.

Rim: Hollow rim type 1 with round section (11 × 11mm).

Band A inserted 8mm into the hollow rim.

Band A: 65mm wide with dogleg 12mm below the rim. The handle mounts are 23mm wide and tri-ribbed with three ridges on the outer surface. The top central ridge of the handle mount passes through band A just below the rim and is hammered over a washer butted up to the rim on the interior. The south handle washer is 25 × 25mm and square, over a rectangular iron patch 750 × 550mm riveted to band A. The north handle, attachment and washer were detached prior to burial. Large rectangular iron patch 50 × 200mm and secured to band A with iron rivets at north handle. Possible joins in band A close to both handles. North handle: interior, visible 31mm from handle attachment; exterior, adjacent to the north handle. Overlap joined with 4mm square iron rivets and an additional iron patch with one iron rivet 9mm in diameter over the north handle join on the exterior. South handle: exterior, possible join in iron visible 45mm to the right of the handle attachment; interior, large patch obscuring the join.

Handles: 105mm in diameter with a circular cross section of 10mm. The orientation of the handles during burial: hanging down as cauldron was deposited upright.

Band B: Width 280mm. Attached to band A with round copper alloy rivets, exterior 5mm in diameter and domed, interior rivet head diameter 4mm. A/B overlap is 16mm. Distance between rivets is regular at 24–6mm. No obvious vertical join in band B. Lower edge of band B not present – no B/C join, edge not obviously cut.

Bowl C: Not present.

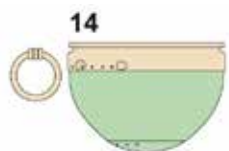
Damage: The base of the cauldron missing at time of deposition, no evidence for the rivet holes of the B/C join. North handle, handle mount and washer not present at deposition.

Repairs: None visible.

Tool marks: None noted.

Residues: Black residue on the interior and exterior of the rim and band A. Sooty deposit on the exterior copper alloy of band B.

Mineralised organic remains: None noted.



Cauldron 14

Associated SF nos: SF153.

Images associated with cauldron 14 in this volume: **Figs 16, 17, 21, 27a–b, 30, 43 and 53.**

Position/orientation in the ground: In the east of the pit inside vessels 15 and 9, positioned on side with the mouth of the cauldron to the southwest. The handles are positioned east–west with the east handle at the bottom and the west handle at the top of the deposit.

Cauldron type: Globular.

Dimensions: Diameter 310mm. Approximate depth 230mm.

Rim: Hollow rim type 1 with circular cross section of 13 × 15mm. Band A extends into the rim by 7mm.

Band A: 54mm wide with dogleg below rim. The handle mounts are 28mm wide and tri-ribbed with three ridges on the outer surface. The top central ridge of the handle mount passes through band A just below the rim and is hammered over a washer rim on the interior. The east and west handle washers are missing. A possible join in band A is visible on the interior and exterior approximately 20mm from the west handle (missing) with an overlap of 8mm. Damage and patching to band A at east handle may obscure the join. Hexagonal handle stops 25mm across and 5mm deep riveted through band A approximately 50mm each side of the handle attachment and 5mm from the bottom edge of band A. Domed over on the interior. (*Note:* Although only one handle stop is present on each side of the cauldron, damage to band A on the east side, an un-relocated handle stop of the same dimensions from excavation to the west side, and their off-centre position indicate that there were probably originally two at each handle.)

Handles: 100mm in diameter with a circular cross section of 12mm. Orientation of the handles during burial: up.

Band B: 150mm wide and attached to band A with round copper alloy rivets, 5–8mm internal diameter and 5mm domed on the exterior. Distance between rivets is regular at 18mm. A/B overlap is 9mm. No obvious vertical join in band B.

Bowl C: Diameter approximately 180mm. Estimated depth 30mm. Joined to band B at the B/C join with round-headed rivets. Rivet head diameter 3mm external, 4mm internal, regular spacing of 21mm with a B/C overlap of 18mm.

Damage: The base of the cauldron damaged either prior to or

during burial. Handle stop to the left of the east handle not present – area of patching and damage pre-deposition. East handle washer and west side of cauldron damage is probably due to collapse during burial and subsequent excavation damage. Uppermost handle not present – in an area truncated by metal detectorist's excavation.

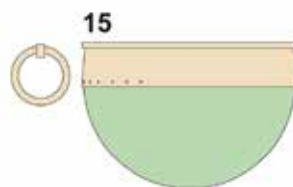
Repairs:

1. Three rectangular iron patches 35 × 30mm, 85 × 25mm and 85 × 20mm on the interior of band A covering damage in the area of the missing east handle stop. Band A has possibly been cut or shaped on the exterior of the cauldron in the area of the repair.
2. Possible copper alloy patching to the bottom of the copper alloy bowl C (condition too poor to determine extent).

Tool marks: Distinct cut edge and over-cut marks on band B at the B/C join.

Residues: Black residue on the exterior of the rim and band A below the rim and interior of copper alloy bowl C. Sooty deposit on the exterior of the bowl C.

Mineralised organic remains: Mineralised plant remains present on the top and sides of the rim and exterior of band A. Randomly aligned small plant remains suggesting packing material.



Cauldron 15

Associated SF nos: SF154.

Images associated with cauldron 15 in this volume: **Figs 16, 17, 43, 61 and 70.**

Position/orientation in the ground: In the east of the pit, positioned upright within vessel 9, with 14 within. The handles are positioned northwest–southeast.

Cauldron type: Globular.

Dimensions: Diameter 440mm. Depth approximately 290mm.

Rim: Solid type 1 sub-rectangular rim 14 × 14mm. Band A extends 11mm into the rim.

Band A: 86mm wide. Straight convex band. The plain handle mounts are 16mm wide and pass through band A and are hammered over a rectangular washer butted up to the rim on the interior. Southeast handle washer 27 × 42mm; northwest handle washer 23 × 44mm. A possible join in band A is visible on the interior approximately 25mm to the left-hand side of the east handle; the overlap is not visible on the exterior. Damage to band A at the west handle may obscure the join on this side of the cauldron.

Handles: 120mm in diameter. 15mm round in cross section. West handle was at 90 degrees to the cauldron and east handle resting against the rim, but rotated 45 degrees indicating that the handles were able to pivot as well as rotate.

Bowl C: Bowl attached directly to band A with no band B. Diameter at A/C join 440mm. Depth of bowl 197–220mm.

Bowl C attached directly to the interior of band A with A/C overlap of 7mm. Copper alloy rivets along the A/C join, exterior 5–6mm domed, interior 3mm, regular spacing of 18–21mm apart.

Damage: The base of the copper alloy bowl damaged before deposition or during burial. The copper alloy of the bowl has several small tears 5–10mm in length radiating vertically on the interior of the bowl which have not been repaired.

Repairs: Extensive patching at the A/C join to stress fractures and possibly to damage in copper alloy and iron:

1. Triangular copper alloy patch 48 × 44mm over stress fracture on the interior of the bowl along the A/C join. Attached with copper alloy rivets hammered flush, interior 2mm, exterior 3–4mm.
2. Triangular copper alloy patch 21 × 31mm over stress fracture on the interior of the bowl along the A/C join. Attached with copper alloy rivets hammered flush, interior 2mm, exterior 3–4mm.
3. Triangular copper alloy patch >42 × >14mm over stress fracture on the interior of the bowl along the A/C join. Attached with copper alloy rivets hammered flush, interior 2mm, exterior 3–4mm.
4. Triangular copper alloy patch 26 × 33mm over stress fracture on the interior of the bowl along the A/C join. Attached with copper alloy rivets hammered flush, interior 2mm, exterior 3–4mm.
5. Triangular copper alloy patch 35 × 43mm over stress fracture on the interior of the bowl along the A/C join. Attached with copper alloy rivets hammered flush, interior 2mm, exterior 3–4mm.
6. Triangular copper alloy patch 19 × 19mm over stress fracture on the interior of the bowl along the A/C join. Attached with copper alloy rivets hammered flush, interior 2mm, exterior 3–4mm.
7. Area of top of bowl at A/C join on north section of the bowl repaired with section of copper alloy 18 × 190mm at time of construction.
8. Rectangular iron patch 20 × 30mm across A/C join on the interior and riveted to both band A and bowl (but not extending onto the copper alloy on the exterior) with iron rivets.
9. Rectangular iron patch 20 × >10mm across A/C join on the interior and riveted to both band A and bowl (but not extending onto the copper alloy on the exterior) with iron rivets.
10. Rectangular iron patch 24 × 37mm across A/C join on the interior and riveted to both band A and bowl (but not extending onto the copper alloy on the exterior) with iron rivets.
11. Rectangular iron patch 17 × 35mm across A/C join on the interior and riveted to both band A and bowl (but not extending onto the copper alloy on the exterior) with iron rivets.
12. Rectangular iron patch 17 × >30mm across A/C join on the interior and riveted to both band A and bowl (but not extending onto the copper alloy on the exterior) with iron rivets.
13. Rectangular iron patch 23 × 30mm across A/C join on the interior and riveted to both band A and bowl (but

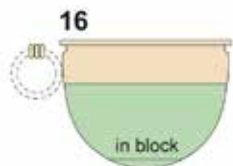
not extending onto the copper alloy on the exterior) with iron rivets.

14. Rectangular iron patch 21 × 38mm across A/C join on the interior and riveted to both band A and bowl (but not extending onto the copper alloy on the exterior) with iron rivets.
15. Rectangular iron patch 36 × 36mm across A/C join on the interior and riveted to both band A and bowl (but not extending onto the copper alloy on the exterior) with iron rivets.
16. Rectangular iron patch 28 × >15mm across A/C join on the interior and riveted to both band A and bowl (but not extending onto the copper alloy on the exterior) with iron rivets.
17. Iron patch 20 × 17mm riveted to the exterior of the bowl under the A/C join (therefore attached at the time of construction) attached with copper alloy rivets.
18. Copper alloy rivet washer 9 × 9mm on exterior of C adjacent to A/C join.
19. Copper alloy rivet washer 10 × 15mm on exterior of C adjacent to A/C join.
20. Iron rivet washer 9 × 11mm on exterior of C adjacent to A/C join.
21. Rectangular copper alloy patch 28 × 13mm on the interior of the bowl over small tears in the metal held in place by small (2mm diameter) copper alloy rivets in each corner.
22. Triangular copper alloy patch 35 × 30mm on the interior of the bowl over small tears in the metal held in place by small (3mm diameter) copper alloy rivets in each corner.
23. Rectangular copper alloy patch 35 × 21mm on the interior of the bowl over small tears in the metal held in place by 3mm copper alloy rivets in each corner.
24. Rectangular copper alloy patch 31 × 15mm on the interior of the bowl over small tears in the metal held in place by 3mm copper alloy rivets in each corner.
25. Rectangular copper alloy patch 27 × 11mm on the interior of the bowl over small tears in the metal held in place with two 3mm copper rivets in opposite corners.
26. Three overlapping rectangular copper alloy patches on the interior of the base of the bowl: 31 × 44mm held by 3mm copper alloy rivets in each corner; 49 × 13mm held by two copper alloy rivets; 15 × >22mm held by two copper alloy rivets.

Tool marks: Linear tool or stake marks on the interior bowl of the cauldron with their length radiating from the centre of the bowl. Small dimpled hammer marks on the base of the bowl.

Residues: Exterior base of the bowl covered in a 'sooty' residue. Thick black food residues sampled from the interior of the bowl and on the exterior of band A below the rim.

Mineralised organic remains: Mineralised organic remains of packing material preserved extensively on the exterior and interior of the rim and band A, as well as on the exterior and interior of the copper alloy bowl, indicating that the nest of cauldrons 9, 14 and 15 had organic packing between them when deposited in the pit.



Cauldron 16

(Based on information obtained from CT scan)

Associated SF nos: UK1.

Images associated with cauldron 16 in this volume: **Figs 16, 17, 39, 40 and 43.**

Position/orientation in the ground: In the centre of the pit deposited the right way up directly underneath cauldron 17 and at the base of the cauldron 5/6 block.

Cauldron type: Globular.

Dimensions: Diameter 332–40mm. Estimated depth 260mm.

Rim: Hollow rim type 1 with circular cross section 18 × 11mm.

Band A: 80mm wide with dogleg below rim. The handle mounts are tri-ribbed with three ridges on the outer surface attached to band A just below the rim.

Handles: Unknown.

Band B: Band B width 157mm.

Bowl C: Diameter 177mm. Depth 16mm.

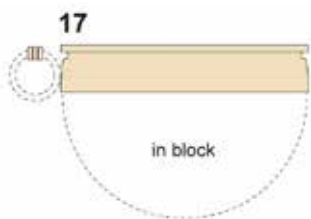
Damage: Unknown.

Repairs: Unknown.

Tool marks: Unknown.

Residues: Unknown.

Mineralised organic remains: Unknown.



Cauldron 17

Associated SF nos: UK2.

Images associated with cauldron 17 in this volume: **Figs 16, 17, 39, 40 and 43.**

Position/orientation in the ground: In the centre of the pit deposited upside down directly over the mouth of cauldron 16 and under cauldron 6 within block 5/6.

Cauldron type: Globular.

Dimensions: Diameter 505mm. Estimated depth 350mm.

Rim: Hollow rim type 1 with circular cross section 18 × 18mm.

Band A: 76mm wide with dogleg below rim. The handle mounts are tri-ribbed with three ridges on the outer surface attached to band A just below the rim.

Handles: Unknown.

Band B: Unknown.

Bowl C: Unknown.

Damage: Unknown.

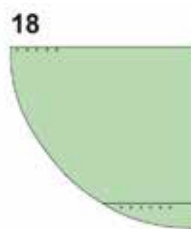
Repairs: Unknown.

Tool marks: Unknown.

Residues: Unknown.

Mineralised organic remains: Unknown.

Cauldron fragments 18–22



Cauldron fragment 18

Associated SF nos: SF4, SF12, SF18, SF43, SF45, SF49, SF51, SF52, SF53 and SF54.

Images associated with cauldron fragment 18 in this volume: **Figs 16, 17, 43, 57a–b, 68a–b and 76.**

Position/orientation in the ground: At the north edge of the pit with interior surface of the vessel facing up and placed on top of the stacked vessels 7, 12 and 13. The A/B join to the south and section C to the north.

Description: A triangular-shaped fragment (possibly one-quarter to one-third) cut from copper alloy band B and bowl C sections of a cauldron and intentionally deposited as a fragment. 814mm along the A/B edge and 520mm to the bottom of section C.

Band B: 320mm in width, with 34 rivet holes 3mm in diameter evenly spaced at 21–5mm, except where positioned either side of fatigue cracks along the A/B join. A/B overlap of 8–11mm. The length of remaining iron rivets (on the exterior) suggest the iron of band A was approximately 1mm thick.

Bowl C: Estimated diameter at top of bowl C approximately 330–50mm. Estimated depth 40mm. B/C overlap 30–2mm riveted by a double, offset row of rivets, 5mm interior, 3–4mm exterior diameter, hammered from interior to exterior at regular spacing of 24–6mm.

Damage: Buried as a fragment with no iron rim, band A or handle.

Repairs: Five fancy patches over fatigue cracks on the interior of band B at the A/B join:

1. Remains of rectangular copper alloy scalloped patch 10 × 43mm over fatigue crack on the interior of band B at the A/B join. Copper alloy rivets through the centre of alternate scallops. Interior and exterior rivet diameter 2mm flush. Rivet holes 1mm diameter. Scallops 3mm in length with cut edges.
2. Tapering scalloped copper alloy patch 32 × 11mm over fatigue crack on the interior of band B at the A/B join. Internal and external copper alloy rivet diameter 2mm flush, rivet holes 1mm diameter through the centre of alternate scallops. 3mm scallop length.
3. Tapering scalloped copper alloy patch 23 × 11mm over fatigue crack on the interior of band B at the A/B join. Internal and external copper alloy rivet diameter 2mm flush through rivet holes 1mm diameter, riveted through the centre of alternate scallops. 3mm scallop length.
4. Double s-shaped copper alloy patch 24 × 10mm over fatigue crack on the interior of band B at the A/B join. Held in place by five flush copper alloy rivets. Rivet diameter 3mm internal and external.
5. Tapering copper alloy patch with straight sides and a scalloped tip 26 × 11mm over fatigue crack on the

interior of band B at the A/B join. Held in place by eight flush copper alloy rivets. Rivet diameter internal and external 2mm, through rivet holes 1mm diameter.

6. Large rectangular copper alloy patch 88×19 mm running lengthways on the interior of band B from A/B join with upper corner overlapping scalloped patch 3. Held in place by ten copper alloy rivets, internal 5mm flush, external 4mm domed.
7. Scalloped triangular copper alloy fancy patch 40×30 mm half way up on the interior of band B. Three copper alloy rivets internal 4mm. Scallops 14mm length.
8. Tongue-shaped copper alloy patch 25×24 mm on the interior of bowl C held in place with three copper alloy rivets, 4mm internal diameter.
9. Large tongue-shaped copper alloy patch 45×45 mm on the exterior of band B between the B/C join. Five copper alloy rivets, 4mm interior and exterior diameter.
10. Remains of a rectangular copper alloy patch $>55 \times 35$ mm on the exterior of band B between the B/C join. Six copper alloy rivets, 4mm internal and external diameter.
11. Remains of a large curved copper alloy patch $>120 \times 15$ mm on the exterior of band B. Rivets 4mm internal and external rivet head diameter.
12. Remains of copper alloy patching on the exterior of bowl C. Three areas $>35 \times 25$ mm fragmentary.

Tool marks: Marking out lines on triangular fancy patch.

Edges down band B and C where fragment has been removed from the cauldron appear to have been cut and then hammered. Scalloped edges cut and filed.

Residues: Sooty deposits on the outside of band B and bowl C. Areas of residues on the interior of band B.

Mineralised organic remains: Unknown.

19



Cauldron fragment 19

Associated SF nos: SF16.

Images associated with cauldron fragment 19 in this volume: **Figs 16, 17, 43, 59, 66 and 90.**

Position/orientation in the ground: Placed upside down over the northeast portion of cauldron 4.

Description: Bowl section C of unknown cauldron, deposited separately in pit.

Band B: Width >22 mm remaining at B/C join.

Bowl C: Diameter 382mm. Depth approximately 60mm. B/C overlap of 13–26mm. Rivets are placed regularly at 10–14mm intervals except at either side of fatigue cracks. Rivet heads are square on the interior (3–4mm) and round and domed over on the exterior (2–4mm). Rivet holes punched from the interior to the exterior.

Damage: Detached along band B close to the B/C join and placed in the ground as a fragment; rough edges therefore not cut.

Repairs:

1. Tongue-shaped copper alloy patch 70×22 mm over fatigue crack on interior of C with one edge between

B/C join. Six copper alloy rivets, internal 4mm flush, external 4mm flush.

2. Partial remains copper alloy patch $60 \times >15$ mm over fatigue crack on interior of C with one edge between B/C join. Six copper alloy rivets, internal 4mm square, external 4mm round.
3. Square copper alloy patch 34×34 mm on the interior of band B at B/C join. Four copper alloy rivets, internal 2mm square, external 3mm round.
4. Partial remains of a copper alloy patch or overlap on band B at B/C join $>42 \times >14$ mm. Four copper alloy rivets, internal 3–4mm square, external 4mm round. Rivets extend through C to the exterior. One rivet with square copper alloy rivet washer on the interior.

Tool marks: Marking out lines visible on the exterior of the bowl 12mm from, and running parallel to, the bowl edge and perpendicular lines mark the placing of rivets. Elliptical hammer marks visible on the exterior following the curve of the bowl. Vertical and horizontal tool marks present on the exterior of B. Snip marks visible on the edge of C, but wavy edge indicated hammering after cutting.

Residues: Sooty deposit present on the exterior of the vessel. Food residues on interior of the vessel. Residue samples taken from the interior bowl of vessel, between copper alloy sheets of the B/C overlap.

Mineralised organic remains: Unknown.

20



Cauldron fragment 20

Associated SF nos: SF23.

Images associated with cauldron fragment 20 in this volume: **Figs 16, 17, 43 and 74.**

Position/orientation in the ground: Located in the vicinity of vessel 1 with outer surface uppermost (exact location unknown – truncated by initial excavation).

Description: Fragment of copper alloy sheet from band B.

Rivet spacing on the A/B join and location in the pit suggest it might be part of cauldron 21.

Band B: >160 mm, A/B overlap 14mm with iron rivets at 26–8mm intervals and circular heads 4mm in diameter punched from interior to exterior.

Damage: Buried as a fragment but may be related to SF58 and 100.

Repairs:

1. Copper alloy paperclip repairs 27mm below A/B join. Covered on interior by large patch, exterior flaps 3×5 mm.
2. Copper alloy paperclip repair 40mm below A/B join. Exterior flaps 4×4 mm, interior fold 6×11 mm.
3. Small copper alloy repair on interior 15×8 mm to fatigue crack on A/B join. Four copper alloy rivets 2mm diameter, riveted interior to exterior.
4. Irregular trapezoid copper alloy patch 58×100 mm positioned just below A/B join on the interior. 11 copper alloy rivets, internal 5mm, external 4mm. Punched interior to exterior. Covers paperclip repair and riveted

patch (four rivets visible on exterior, 2mm rivet heads).

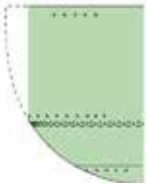
5. Rectangular copper alloy patch 32 × 42mm. One corner passes through a cut below A/B join to exterior of cauldron. Four copper alloy rivets, internal 3mm, external 4mm. Punched interior to exterior.
6. Copper alloy paperclip repair at the top edge of patch 4, two triangular flaps 5 × 3mm.

Tool marks: Linear tool marks on the exterior of the vessel running at a diagonal to the band. Edge of B cut and then hammered.

Residues: Black sooty exterior. Residue samples taken from interior and exterior of copper alloy sheet band B.

Mineralised organic remains: None noted.

21



Cauldron fragment 21

Associated SF nos: SF58.

Images associated with cauldron fragment 21 in this volume: **Figs 16, 17, 29 and 55.**

Position/orientation in the ground: On the west side of the pit under the rim of cauldron 4 and adjacent to cauldron fragment 20 and vessel 1 (area truncated by initial excavation).

Description: Large riveted section of copper alloy sheet from bands B1 and B2 including A/B and B/C join (fragment of rim from cauldron 4 corroded to sheet but unrelated). Rivet spacing on the A/B join and location in the pit suggest it might be part of cauldron fragment 20.

Band B1: 230mm in width. A/B overlap 10mm with recessed join. Rivet holes along the A/B band join punched from interior to exterior at 26mm regular intervals. Rivets removed prior to deposition, 4mm rivet holes punched interior to exterior. B1/B2 overlap is 20mm with B2 riveted to the interior of B1. The lower edge of band B1 on the exterior of the B1/B2 join is scalloped. Each scallop is approximately 14mm wide and 7mm deep. Rivets 4mm domed on exterior pass through the centre of each scallop with a second offset row. Both rows of rivets spaced at a regular 16mm. Additional repair riveting along the edge of B2 at 29mm regular intervals linked to large patch described below. Rivets interior 5mm square, exterior 4mm.

Band B2: 80–7mm wide one finished end. B2/C overlap 19mm with rivets at 20mm intervals 4mm internal 3mm external. Second set of rivet heads along B2/C also 4mm present at 16mm intervals on the interior but not visible on the exterior of the cauldron.

Bowl C: Not present. Bowl diameter along the bottom of B2 260mm.

Damage: Appears to have been buried as a fragment, maybe related to SF23 and SF100.

Repairs:

1. Fragment of rectangular copper alloy patch along B1/

B2 join on interior; 62 × >25mm with both 5mm raised and 3mm flush rivets similar to those on B1/B2 join.

2. Copper alloy patch >40 × >50mm on the exterior of band B2 along B1/B2 join between B2 and remains of scalloping of B1.

Tool marks: The B1 band has rows of linear tool marks 3–4mm that run perpendicular to the length of the band on the bottom third and parallel to it on the top two-thirds.

Residues: External black sooty residue on exterior of cauldron. Residue samples taken from interior of cauldron between B2/C join.

Mineralised organic remains: None noted.

22



Cauldron fragment 22

Associated SF nos: SF100.

Images associated with cauldron fragment 22 in this volume: **Figs 16, 17, 43 and 72.**

Position/orientation in the ground: Excavated from above cauldron fragment 19 (exact location unknown, truncated by initial excavation).

Description: Copper alloy fragments from base of cauldron including bands B1 and B2 and bowl C. Possibly folded and incomplete when deposited.

Band B: Constructed from two bands of copper alloy B1 and B2. B1 >80mm in width. B2 24mm wide and riveted to the outside of B1 with the B1/B2 overlap 10–11mm secured with rivets punched from the interior to the exterior with square rivet heads 3–4mm on the interior and round rivet heads 2–3mm on the exterior and placed irregularly 14–26mm. Along the edge of B1 at the B1/B2 join there is a row of rivet heads/holes which do not penetrate to B2 and the exterior of the cauldron. The redundant rivets are spaced regularly at 14mm, and circular on the interior 3mm in diameter (different from the functioning B1/B2 and B2/C rivets).

Bowl C: Curvature of the bowl indicates a probable diameter of c. 180–200mm. Riveted to the outside of B2 with a B2/C overlap of 10–13mm. Rivets spaced irregularly 16–23mm apart. Rivet heads square on the interior 3–4mm, round on the exterior 2–3mm.

Repairs: Row of redundant rivets/holes along B1 at B1/B2 join indicates that B2 and C are possibly later additions or repairs. Sub-triangular copper alloy patch 25 × 17mm on C between B2/C join. Further evidence of other possible patches along the B1/B2 and B2/C joins including square copper alloy rivet washers on interior and exterior, possibly on the opposite side to patch repairs.

Tool marks: Sharp cut edge to C and B2 along B1/B2 join.

Residues: Dark sooty residue on the exterior of the vessel.

Mineralised organic remains: None noted.

Other significant fragments

Fragment of copper alloy sheet from area of SF9 – north handle: Copper alloy sheet with no features, 210 × 140mm at widest points.

Associated with two further fragments: Fragment of copper alloy sheet and scalloped-edged copper alloy patch

from area of B along A/B join. Overall size of fragment 40×43 mm. Patch 43×35 mm trapezoidal in shape held in place by eight copper alloy rivets with rivet head diameters of 3mm internal, 3mm external. Large iron rivet 5mm external rivet head diameter at upper edge adjacent to A/B join.

Fragment of copper alloy 75×90 mm from band B with rivet holes along A/B join spaced evenly at 25mm. Rivet hole diameter 2–3mm. Rivet spacing and position in the pit indicate possible association with cauldron fragments 20/21.

Fancy patch U/S spoil heap: Fragment of copper alloy patch $>20 \times 25$ mm, with 5mm scallops at side and bottom attached to copper alloy sheet of B adjacent to A/B join and secured with copper alloy rivets 3mm internal and external.

Fancy patch SF100: Tapered scalloped-edged copper alloy patch 33×15 mm covering stress fracture in band B adjacent to A/B join. Scallops 2–3mm riveted to B with three copper alloy rivets, internal 4mm square, external 3mm, riveted interior to exterior.

Fancy patch SF3: Fragment of copper alloy 70×60 mm from band B of unknown cauldron including A/B join. Copper alloy rivets along the A/B join: 4mm internal raised at 36mm interval. Tapering scalloped patch $25 \times >54$ mm with 6–8mm scallops secured with rivets: internal 4mm; external 3mm; hammered interior to exterior.

Fancy patch (100): Scalloped copper alloy patch $44 \times >37$ mm from adjacent to A/B join. 5mm scallops riveted through alternate scallops. Copper alloy rivets 4mm internal. Iron rivet at top edge of patch possibly from A/B join, square-headed rivet 4mm internal and adjacent rivet hole in centre of patch. Possibly from cauldron 5.

SF53: From interface between cauldrons 18, 5 and 7. Fragments of iron from bottom of band A (97×35 mm). Possible secondary decorative plate.

SF100: Fragments removed by metal detectorist. Seven fragments of copper alloy sheet from band B of unknown cauldron, largest 270×130 mm and 221×160 mm. Distinguishing features: large fragmentary patch on the interior larger than 80×40 mm. One fragment has the A/B join, iron rivets 3mm interior and exterior and spaced at 24mm intervals. Rivets similar to cauldron fragments 20/21.

SF3: Fragments of copper alloy from band B of unknown cauldron close to A/B join. Depth of band >140 mm, copper alloy rivets 3mm exterior and interior, 21mm spacing.

SF96: Fragments of copper alloy from band B adjacent to the A/B join. Depth of B >70 mm. A/B overlap 10mm. Iron rivets along A/B join spaced at 39mm. 4mm internal rivet diameter. Scalloped trapezoid-shaped copper alloy patch along A/B join covering fatigue crack 22×16 mm, held by four copper alloy rivets, 3mm internal and external flush.

Possibly from cauldron 5.

Two other fragments have overlapping riveted patching:

1. Triangular copper alloy patch $18 \times >18$ mm. Two visible copper alloy rivets 5mm internal, overlaid by house-shaped copper alloy patch 31×17 mm, five copper alloy rivets, 2mm internal.
2. Five overlapping copper alloy patches: $>39 \times >18$ mm, rivets 2mm internal and external; overlaid by rectangular patch 15×8 mm, two rivets 2mm internal and external; fragment of patch $>19 \times >12$ mm, square rivet 3mm internal and external; fragment of patch $16 \times >12$ mm, rivets 2mm internal; fragment of patch $>7 \times >5$ mm, rivet 2mm internal.

Fragment of rim from bottom of cauldron 4, block no. 41: 30mm section. Hollow rim type 1, 14×14 mm. Dogleg to band A. Band A >25 mm rim.

SF99: Fragment of band A 75×55 mm adjacent to A/B join. Depth of band A >55 mm. A/B join overlap 14mm. Copper alloy rivets along A/B join, internal 4–5mm square. Spacing 26mm apart. Trapezoidal copper alloy patch 37×14 mm over stress fracture with narrow end at A/B join. Three copper alloy rivets in line down centre of patch, internal 4mm, external 3mm, punched interior to exterior. 2mm flush rivet at top of patch. Possibly from cauldron 6.

SF99: Fragment of copper alloy 65×50 mm with sub-triangular copper alloy patch 25×14 mm with three copper alloy rivets, interior 4mm, exterior 3mm raised, punched interior to exterior.

SF9 excv: Handle mount with part of band A and washer attached. Mount 24mm in width, tri-ribbed with bands 6, 12, 6mm. Square handle washer 22×25 mm.

Appendix A

Analysis and Metallography of an Iron Age Sheet Bronze Vessel

Peter Northover

A fragmentary sheet bronze vessel (SF100), excavated near Chiseldon, Wiltshire, was submitted for metallurgical analysis. The purpose of the study was, if possible, to assign a date to the vessel and, in particular, to determine whether it might be of Iron Age date.

Sampling and analysis

A small corroded fragment was detached manually and prepared as a single sample. The sample, here labelled #R2699, was hot-mounted in a carbon-filled thermosetting resin, then ground and polished to a 1pm diamond finish. Analysis was by electron probe microanalysis with wave length dispersive spectrometry; operating conditions were an accelerating voltage of 2501, a M am current of 30nA, and an X-ray take-off angle of 40°. Sixteen elements were sought, as listed in **Table 16**; pure element and mineral standards were used with a counting time of 105 per element. Detection limits were typically 100–200 ppm with the exception of 400 ppri for gold.

Ten areas, each 30 × 50pm, were analysed on the sample; the individual compositions and their means, normalised to 100%, are shown in the table. All concentrations are in weight%. After analysis the sample was examined metallographically in the as-polished state and etched states. The etch used was an acidified aqueous solution of ferric chloride further diluted with ethanol.

The alloy

The sheet had been formed from an unleaded low- to medium-tin bronze with 6.4% tin and 0.6% lead. Most impurities were at low levels but are none the less significant in determining the origins and history of the metal. These are 0.03% iron, 0.03% cobalt, 0.04% nickel, 0.18% arsenic, 0.04% antimony and 0.07% silver. There were also very small traces of zinc and silver.

Although the analysis of copper alloys from archaeological contexts has something of a bias to the earliest periods, there are nonetheless enough data from all periods for much of the British Isles to give a reasonably robust relative chronology of alloy types and impurity patterns (see Northover in Cunliffe 1988, 186–96; Northover in Sharples 1991, 159–65; Northover in Lambrick and Allen 2004, 346–54). The chronology can become more robust when a single object type, for example, sheet metal vessels, is under discussion. Here the key elements are cobalt, nickel,

Table 16 Analysis of an Iron Age sheet bronze vessel. All concentrations are in weight%

Sample	Fe	Co	Ni	Cu	Zn	As	Sb	Sn	Ag	Bi	Pb	Au	S	Al	Si	Mn
R2699/1	0.02	0.02	0.04	93.75	0.01	0.16	0.02	5.34	0.03	0.00	0.56	0.00	0.01	0.01	0.02	0.01
R2699/2	0.02	0.03	0.05	91.40	0.00	0.18	0.07	7.46	0.02	0.00	0.74	0.00	0.02	0.00	0.02	0.01
R2699/3	0.03	0.05	0.08	89.75	0.00	0.28	0.06	8.66	0.00	0.00	0.81	0.15	0.12	0.00	0.00	0.00
R2699/4	0.02	0.03	0.02	90.16	0.00	0.23	0.08	8.71	0.03	0.00	0.62	0.00	0.07	0.00	0.02	0.02
R2699/5	0.02	0.04	0.02	96.09	0.00	0.13	0.00	3.51	0.04	0.00	0.12	0.04	0.02	0.00	0.00	0.00
R2699/6	0.06	0.02	0.05	93.67	0.00	0.12	0.05	4.20	0.00	0.00	1.40	0.00	0.43	0.00	0.00	0.00
R2699/7	0.03	0.02	0.00	92.94	0.04	0.11	0.06	6.01	0.03	0.00	0.71	0.05	0.00	0.00	0.01	0.00
R2699/8	0.04	0.04	0.03	92.88	0.00	0.26	0.02	6.57	0.00	0.00	0.10	0.07	0.00	0.00	0.00	0.00
82699/9	0.01	0.03	0.02	91.83	0.03	0.16	0.03	6.86	0.00	0.00	0.89	0.08	0.05	0.01	0.00	0.00
82699/10	0.03	0.01	0.06	92.91	0.00	0.19	0.01	6.34	0.02	0.00	0.38	0.00	0.01	0.01	0.02	0.00
R2699/Mean	0.03	0.03	0.04	92.54	0.01	0.18	0.04	6.37	0.02	0.00	0.63	0.04	0.07	0.00	0.01	0.00

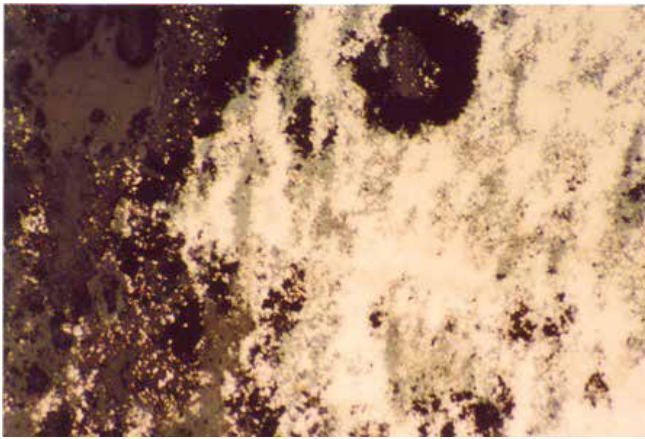


Figure 107 #R2699, showing massive surface corrosion and bands of intergranular corrosion, unetched, x125

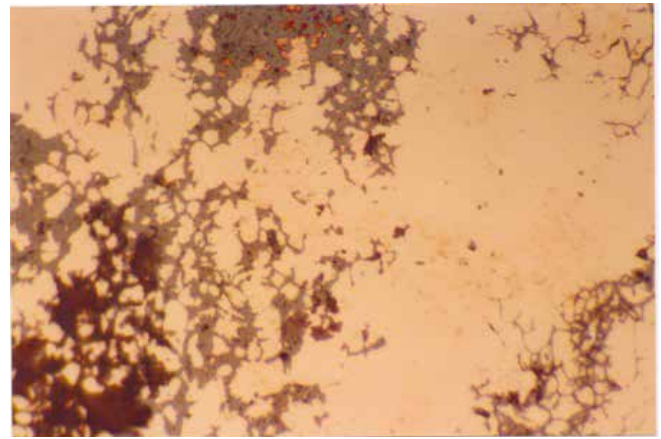


Figure 108 #R2699, detail of intragranular corrosion, unetched, x625

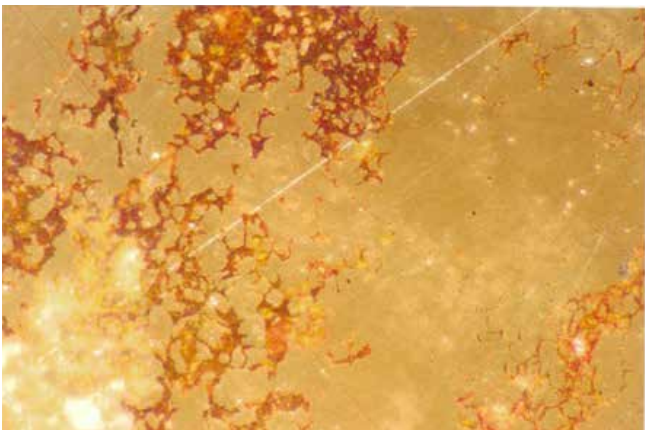


Figure 109 #R2699, as Fig. A.2 but viewed under plane polarised light, unetched, x625

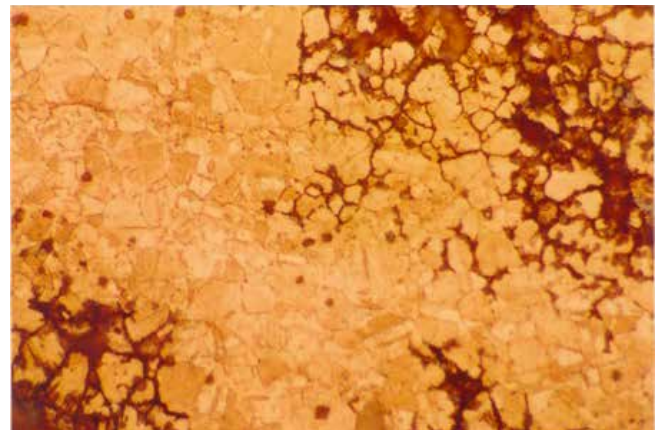


Figure 110 #R2699, fully recrystallised equi-axed grain structure with annealing twins, etched, x625

arsenic and antimony, and in particular the more or less equal concentrations of cobalt and nickel. Even with these relatively low concentrations it is a rather uncommon combination in British archaeology and essentially only occurs on two horizons: the first half of the Middle Bronze Age in southwest England, and much of the La Tène Iron Age in central southern and western England and the Welsh Marches. The Middle Bronze Age examples mainly date to a period before the introduction of sheet bronze vessels and are very much confined to Devon and Cornwall. Besides that, the find of which this vessel formed part contained iron handles and rim reinforcements. Within the La Tène Iron Age in southern Britain there are impurity patterns where the cobalt concentration is roughly equal to or in excess of that of nickel. One contains a significant level of antimony, often >0.10%; this metal may be of Continental origin or contains scrap that was. The other two with low antimony differ in the range of concentrations of cobalt, one having low levels of both, typically up to 0.05–0.06%, and those with higher cobalt, up to 0.5%. Clearly this vessel belongs to the lower cobalt group, which appears to have a longer date range than the higher cobalt group. Indeed, its first occurrences could even pre-date the introduction of La Tène styles into Britain, in that it occurs in analyses of the cauldron from Kincardine Moss in Scotland (Northover in Gerloff 2010). This is one of two surviving vessels that Sabine Gerloff (2010) has classified as ‘B3’ in her publication on the Bronze Age cauldrons and buckets of Atlantic Europe (see

also Joy 2014). These are the final development of the Atlantic two-handled, multi-sheet globular cauldron and need be no later than a date contemporary with the end of Hallstatt D on the Continent. The same pattern then occurs in a sword scabbard from Standlake in the Thames valley, a very early La Tène-style piece. This composition then occurs in small numbers throughout the Iron Age in England until some time around the end of the 1st century BC, certainly no later than the middle of that century.

Metallography

As a solid sample had been taken it was also possible to examine the bronze metallographically to determine whether the microstructure and corrosion pattern are consistent with the suggested Iron Age dating (**Figs 107–10**). The sample was mounted flat so that the section exposed (**Fig. 107**) is roughly parallel with the surface. The micrograph shows massive corrosion at the surface with some preserved grains of bronze. The surviving bulk metal in the sample has been extensively penetrated by intergranular corrosion; in some areas this has been extended by transgranular attack to remove whole sections of grains and leaving either copper corrosion products or a cavity (**Fig. 108**). The overall pattern of corrosion is dictated by segregation of specific elements in the microstructure: when the dendritic microstructure of the cast blank from which the sheet has been worked is flattened by hammering the pattern seen here will be obtained. Examination under

plane polarised light (**Fig. 109**) shows the main corrosion product to have a red colour, identifying it as cuprite. Etching (**Fig. 110**) revealed a fine-grained recrystallised microstructure with annealing twins and little residual cold work. The grain size is 10–15 μ m, suggesting that annealing times are short and the temperature not too elevated.

Conclusions

The composition of this bronze shows that the analysed vessel is of Iron Age date, some time between the 6th and 1st centuries BC; just because the metal became more common, a date between the 4th and 2nd centuries is probably the most likely. The corrosion and microstructure are consistent with those of other Iron Age bronze sheets examined by the writer.

Appendix B

Geophysical Survey Equipment and Data Processing

Ben Urmston

Survey methods and equipment

The magnetic data (Chapter 2) were acquired using a Bartington 601–2 dual magnetic gradiometer system. This instrument has two sensor assemblies fixed horizontally 1m apart allowing two traverses to be recorded simultaneously. Each sensor contains two fluxgate magnetometers arranged vertically with a 1m separation, and measures the difference between the vertical components of the total magnetic field within each sensor array. This arrangement of magnetometers suppresses any diurnal or low frequency effects.

The gradiometers have an effective resolution of 0.03nT over a ± 100 nT range, and measurements from each sensor are logged at intervals of 0.25m. All of the data are stored on an integrated data logger for subsequent post-processing and analysis.

The Leica Viva GNSS receives corrections from a network of reference stations operated by the Ordnance Survey and Leica Geosystems, allowing positions to be determined to an accuracy of *c.* 0.02m in real time.

The survey used 30m \times 30m grids with data collected at 0.25m intervals along traverses spaced 1m apart giving 3,600 measurements per complete 30m grid.

Post-processing

The magnetic data collected during the detailed survey were downloaded from the Bartington system for processing and analysis using both commercial and in-house software. This software allows the data and the images to be processed in order to enhance the results for analysis but minimal data processing was conducted so as not to distort the anomalies.

The XY Plot presented the data as a trace or graph line for each traverse. Each traverse was displaced down the image to produce a stacked profile effect. The greyscale (see **Fig. 5**) presents the data in plan view using a greyscale to indicate the relative strength of the signal at each measurement point.

Appendix C

Anatomical Features of the Four Woods Identified from the Chiseldon Cauldrons

Caroline R. Cartwright

***Fraxinus excelsior* L., European ash (Oleaceae)**

Distinct growth ring boundaries; ring-porous wood; simple perforation plates; alternate intervessel pits (some polygonal); vessel-ray pits with distinct borders, similar to intervessel pits in size and shape throughout the ray cell; fibres with simple to minutely bordered pits; non-septate fibres; thin- to thick-walled fibres; paratracheal parenchyma; vasicentric, aliform, confluent and marginal axial parenchyma; rays 1–3 cells wide; larger rays commonly 4–10 cells wide (variable feature); some tyloses in earlywood vessels.

***Corylus avellana* L., hazel (Betulaceae)**

Distinct growth ring boundaries (sometimes undulating); semi-ring-porous wood to diffuse-porous; some vessels in radial or diagonal pattern; vessels in radial multiples or four or more; angular solitary vessel outline; scalariform perforation plates with 5–10 bars; polygonal, alternate intervessel pits; vessel-ray pits with distinct borders, similar to intervessel pits in size and shape throughout the ray cell; helical (spiral) thickenings present throughout body of vessel element; vascular/vasicentric tracheids present; fibres with simple to minutely bordered pits; non-septate fibres; thin- to thick-walled fibres; diffuse axial parenchyma; rays 1–3 cells wide; aggregate rays present; heterocellular rays: body ray cells procumbent with one row of upright and/or square marginal cells, and body ray cells procumbent with mostly 2–4 rows of upright and/or square marginal cells.

***Betula pendula* Roth, European white/silver birch (Betulaceae)**

Distinct growth ring boundaries; diffuse-porous wood; scalariform perforation plates with 10–20 bars (sometimes up to 40 bars); alternate intervessel pits; very small vessel-ray pits with distinct borders, similar to intervessel pits in size and shape throughout the ray cell; fibres with simple to minutely bordered pits; non-septate fibres; thin- to thick-walled fibres; diffuse sparse axial parenchyma; diffuse-in-aggregates axial parenchyma; rays 1–3 cells wide; larger rays commonly 4–10 cells wide; homocellular rays (all procumbent cells).

***Acer campestre* L., field maple (Sapindaceae)**

Distinct growth ring boundaries; diffuse-porous wood; simple perforation plates; polygonal, alternate intervessel pits; vessel-ray pits with distinct borders, similar to intervessel pits in size and shape throughout the ray cell; helical (spiral) thickenings present throughout body of vessel element; non-septate fibres; thin- to thick-walled fibres; axial parenchyma absent or extremely rare; scanty paratracheal axial parenchyma; axial parenchyma in marginal or seemingly marginal bands; rays mostly 2–4 cells wide; homocellular rays (all procumbent cells); prismatic calcium oxalate crystals present in chambered axial parenchyma cells.

Appendix D

Methods for the Analysis of the Partially Carbonised Residues

Val Steele

In order to avoid the introduction of modern contamination during sample preparation and analysis nitrile gloves were worn at all times, all glassware and tools were solvent washed and high purity reagents were used (Analar or HPLC grade). Method blanks were processed at the same time as the samples to give an indication of the level and type of any contamination introduced during sample preparation and analysis.

Before sample preparation all samples were ground to a fine powder using an agate pestle and mortar and accurately weighed into glass vials.

Sample preparation

Alkaline saponification

Samples were heated at 70°C for one hour with 5ml 0.5M methanolic solution of potassium hydroxide (KOH) containing 5% water. The neutral fraction was extracted in 3 × 0.5ml aliquots of hexane and the remaining residues acidified with *c.* 4ml 1M hydrochloric acid (HCl). Extraction of the acid fraction was carried out as above.

Solvent extraction

The ground, weighed samples were sonicated with 0.5ml DCM:methanol mixture (2:1 v/v) for 15 minutes. After centrifuging at 2,000 rpm for 10 minutes the extracts were pipetted off into clean vials. This process was repeated twice more, combining the extracts.

After extracting the samples, excess solvent was evaporated off the extracts under dry nitrogen (N₂) with gentle heating (40°C). All samples were then transferred to autosampler vials and derivatised by heating at 70°C for 1 hour with N,O bis(trimethylsilyl)fluoroacetamide with 1% trimethylchlorosilane (BSTFA). Excess BSTFA was evaporated off under dry N₂. Prior to analysis by GC-MS a known amount of an internal standard (tetratriacontane) was added to each sample to allow quantification.

GC-MS analysis

Analysis was carried out on an Agilent 6890 GC attached to an Agilent 5973 mass selective detector. The GC was fitted with an SGE HT-5 column, 12m × 0.22mm × 0.1 µm. The oven was programmed as follows: isothermal at 50°C for 2 minutes, rise at 10° per minute to 370°C, isothermal for 15 minutes. Helium was used as the carrier gas at a constant flow of 1.5ml per minute. The on-column injector was temperature programmed to match the oven temperature. The column was inserted directly into the mass spectrometer with the interface at 350°C. Mass spectral data were acquired in scan mode over a mass range of 50 to 750.

Data were analysed using Agilent Chemstation data analysis software. Mass spectral data were interpreted by comparison with the NIST library and other published data.

Sample preparation for stable isotope analysis

Samples were extracted by alkaline saponification as above and methylated by heating for 20 minutes at 70°C with boron trifluoride methanol complex. A standard containing palmitic and stearic acids was methylated at the same time to allow a correction for the modern carbon added to the

samples during methylation. The reaction was quenched with a few drops of deionised water. The resulting fatty acid methyl esters were extracted with three aliquots 2ml hexane, combining the extracts. Excess solvent was evaporated off under a gentle stream of dry N_2 and the samples transferred to small vials. They were then evaporated to dryness. Two

samples (1 and 12) were sent for analysis by GC-C-IRMS together with the methylated standard and samples of the unmethylated palmitic and stearic acids. Correction was made for the methylating carbon using a mass balance equation.

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